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BENSHAW
ADVANCED CONTROLS & DRIVES

RSi SX Series

Sensorless Vector Drive
Hardware Manual

1 to 30HP - 230V CT
1 to 150/200HP - 460V CT/VT
1 to 150/200HP - 600V CT/VT

The Leader In

Solid State Motor Control

Technology

TRADEMARK NOTICE

Benshaw and are  registered trademarks of Benshaw Incorporated.

ModBUS is a registered trademark of Schneider Electric.

DeviceNet is a registered trademark of the Open DeviceNet Vendor Association (ODVA).

Metasys is a registered trademarkof Johnson Controls, Inc.

UL is a trademark of Underwriters Laboratories, Incorporated.

SAFETY PRECAUTIONS

WARNING

1. *This inverter contains high voltage which can cause electric shock resulting in personal injury or loss of life.*
2. *Be sure all AC power is removed from the inverter before servicing.*
3. *Wait at least 5 minutes after turning off the AC power for the bus capacitor to discharge. Measure the DC Bus charge between B+ and B- terminals, ensure DC voltage is below 45V before proceeding.*
4. *Do not connect or disconnect the wires to or from inverter when power is applied.*

CAUTION

1. *Service only by qualified personnel.*
2. *Make sure power-up restart is off to prevent any unexpected operation of the motor.*
3. *Make sure ground connection is in place.*
4. *Make certain proper shield installation is in place.*
5. *Never connect the input power leads to the output terminals of inverter.*

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1 Introduction

USING THIS MANUAL

Layout

This manual is divided into 7 sections. Each section contains topics related to the section. The sections are as follows:

- Introduction
- Technical Specifications
- Installation
- Connection
- Troubleshooting & Maintenance
- Interference Suppression Measures
- Appendices

Symbols

There are 2 symbols used in this manual to highlight important information. The symbols appear as the following:

Electrical Hazard that warns of situations in which a high voltage can cause physical injury, death and/or damage equipment.

Caution that warns of situations in which physical injury and/damage to equipment may occur by means other than electrical.

Highlight marking an important point in the documentation.

BENSHAW SERVICES

General Information

Benshaw offers its customers the following:

- Start-up services
- On-site training services
- Technical support
- Detailed documentation
- Replacement parts

⌘ **NOTE:** Information about products and services is available by contacting Benshaw.

Start-Up Services

Benshaw technical field support personnel are available to conduct on-site training on RSi SX operations and troubleshooting.

On-Site Training Services

Benshaw technical field support personnel are available to conduct on-site training on RSi SX operations and troubleshooting.

Technical Support

Benshaw technical support personnel are available (at no charge) to answer customer questions and provide technical support over the telephone. For more information about contacting technical support personnel, refer to Contacting Benshaw on page 4.

Documentation

Benshaw provides all customers with:

- Hardware Manual - Production # 890020-01
- Parameter Configuration Manual - Production # 890020-02
- Quickstart Reference Guide - Production # 890020-03
- Specification Guide - Production # 890020-04
- Enhanced Keypad Manual - Production # 890020-05
- DeviceNet Manual - Production # 890020-06
- VFD Application Questionnaire - Production # 890020-07
- Reflash Tool Manual - Production # 890020-11
- NEMA 12 Manual - Production # 890020-12
- VFD Start up Questionnaire - Production # 890020-13
- Standard Keypad Mounting Manual - Production # 890020-14
- Application Specific Software Manual - Production # 890020-15
- Product CD
- Drive View

On-Line Documentation

All RSi SX documentation is available on-line at **http://www.benshaw.com**.

Replacement Parts

Spare and replacement parts can be purchased from Benshaw.

CONTACTING BENSHAW

Contacting Benshaw

Information about Benshaw products and services is available by contacting Benshaw at one of the following offices:

Benshaw Inc. Corporate Headquarters
1659 E. Sutter Road
Glenshaw, PA 15116
United States of America
Phone: (412) 487-8235
Fax: (412) 487-4201

Benshaw Canada Controls Inc.
550 Bright Street
Listowel, Ontario N4W 3W3
Canada
Phone: (519) 291-5112
Fax: (519) 291-2595

Benshaw West
7820 E. Evans Drive, Suite 900
Scottsdale, AZ 85260
United States of America
Phone: (480) 905-0601
Fax: (480) 905-0757

Technical support for RSi SX Series is available at no charge by contacting Benshaw's customer service department at one of the above telephone numbers. A service technician is available Monday through Friday from 8:00 a.m. to 5:00 p.m. EST.

⌘ **NOTE:** An on-call technician is available after normal business hours and on weekends by calling Benshaw and following the recorded instructions.

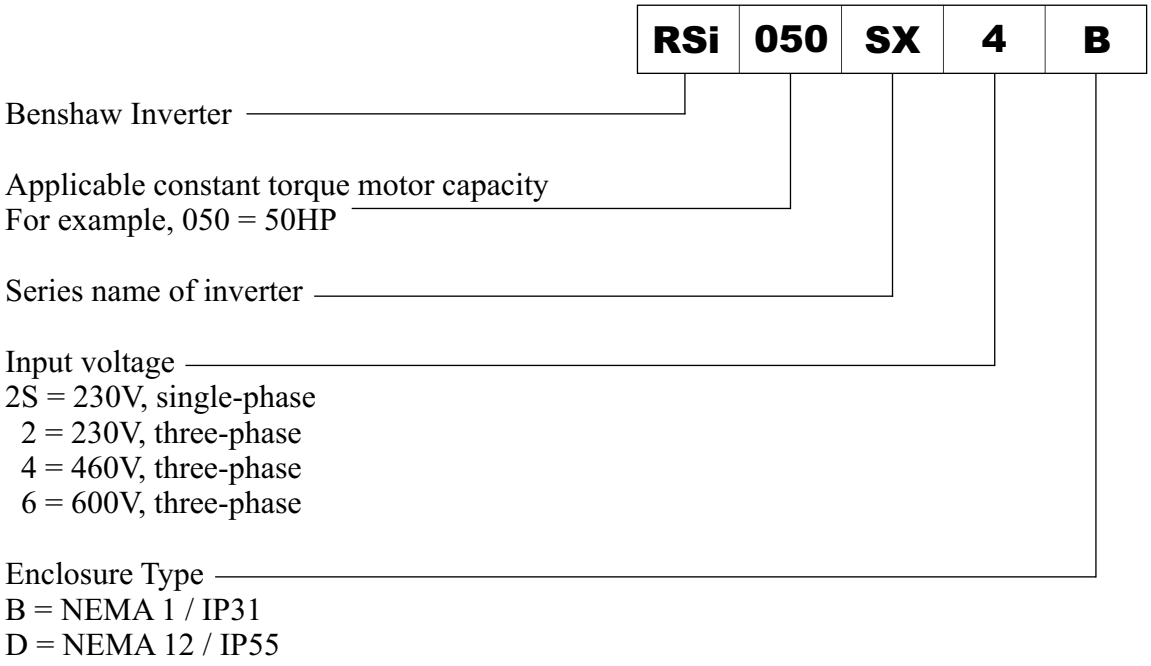
To help assure prompt and accurate service, please have the following information available when contacting Benshaw:
- Name of Company
- Telephone number where the caller can be contacted
- Fax number of caller
- Benshaw product name
- Benshaw model number
- Benshaw serial number
- Name of product distributor
- Approximate date of purchase
- System Voltage
- FLA of motor attached to Benshaw product
- A brief description of the application

INTERPRETING MODEL NUMBERS

Model Numbers

The model number of the RSi SX drive appears on the shipping carton label and on the technical data label affixed to the model. Read the technical data label affixed to the drive and ensure that the correct horsepower and input voltage for the application has been purchased. The numbering system for a Benshaw inverter is shown below.

Figure 1: RSi SX Drive Model Numbers



Notes:

2 Technical Specifications

POWER AND CURRENT RATINGS

Table 1: Ratings for Single-Phase 200 / 230VAC ±10% Models

Model Number	Motor Power				Input Current (A)				Output Current (A)			
	Constant Torque (HP)	Constant Torque (kW)	Variable Torque (HP)	Variable Torque (kW)	Constant Torque (FLA)	Constant Torque (FLA)	Variable Torque (FLA)	Variable Torque (FLA)	Constant Torque (FLA)	Constant Torque (FLA)	Variable Torque (FLA)	Variable Torque (FLA)
					200VAC	230VAC	200VAC	230VAC	200VAC	230VAC	200VAC	230VAC
RSi001SX2S_	1.0	0.75	1.0	0.75	8.9	8.0	8.9	8.0	4.8	4.2	4.8	4.2
RSi002SX2S_	2.0	1.5	2.0	1.5	16.2	14.6	16.2	14.6	7.8	6.8	7.8	6.8
RSi003SX2S_	3.0	2.2	3.0	2.2	23.0	20.7	23.0	20.7	11.0	9.6	11.0	9.6

Table 2: Ratings for Three-Phase 200 / 230VAC ±15% Models

Model Number	Motor Power				Input Current (A)				Output Current (A)			
	Constant Torque (HP)	Constant Torque (kW)	Variable Torque (HP)	Variable Torque (kW)	Constant Torque (FLA)	Constant Torque (FLA)	Variable Torque (FLA)	Variable Torque (FLA)	Constant Torque (FLA)	Constant Torque (FLA)	Variable Torque (FLA)	Variable Torque (FLA)
					200VAC	230VAC	200VAC	230VAC	200VAC	230VAC	200VAC	230VAC
RSi001SX2_	1.0	0.7	1.5(ref)	1.1(ref)	5.6	4.8	6.7	6.7	4.8	4.2	5.7	5.7
RSi002SX2_	2.0	1.5	2.0	1.5	9.0	7.8	9.0	7.8	7.8	6.8	7.8	6.8
RSi003SX2_	3.0	2.2	5.0(ref)	4.0(ref)	12.7	11.0	15.4	15.4	11.0	9.6	13.1	13.1
RSi005SX2_	5.0	3.7	7.5	5.5	20.2	17.5	25.3	25.3	17.5	15.2	22.0	22.0
RSi007SX2_	7.5	5.5	10.0	7.5	29.2	25.3	32.2	32.2	25.3	22.0	28.0	28.0
RSi010SX2_	10.0	7.5	10.0	7.5	37.2	32.2	37.2	32.2	32.2	28.0	32.2	28.0
RSi015SX2_	15.0	11.0	20.0	15.0	52.1	46.2	63.3	63.3	48.3	42.0	54.0	54.0
RSi020SX2_*	20.0	15.0	25.0	18.5	62.1	54.0	68.0	68.0	62.1	54.0	68.0	68.0
RSi025SX2_*	25.0	18.5	30.0	22.0	78.2	68.0	80.0	80.0	78.2	68.0	80.0	80.0
RSi030SX2_*	30.0	22.0	40.0	30.0	92.0	80.0	104.0	104.0	92.0	80.0	104.0	104.0

*Models 20HP and above have DC Link choke.

POWER AND CURRENT RATINGS

Table 3: Ratings for Three-Phase 380 / 460VAC ±15% Models

Model Number	Motor Power				Input Current (A)				Output Current (A)			
	Constant Torque (HP)	Constant Torque (kW)	Variable Torque (HP)	Variable Torque (kW)	Constant Torque (FLA)	Constant Torque (FLA)	Variable Torque (FLA)	Variable Torque (FLA)	Constant Torque (FLA)	Constant Torque (FLA)	Variable Torque (FLA)	Variable Torque (FLA)
					380VAC	460VAC	380VAC	460VAC	380VAC	460VAC	380VAC	460VAC
RSi001SX4_	1.0	0.75	1.5	1.1	3.0	2.4	3.2	3.2	2.4	2.1	2.8	2.8
RSi002SX4_	2.0	1.5	2.0	1.5	5.2	3.9	5.2	3.9	3.8	3.4	3.8	3.4
RSi003SX4_	3.0	2.2	5.0	3.0	7.2	5.6	7.7	7.7	5.7	4.8	6.6	6.6
RSi005SX4_	5.0	4.0	7.5	5.0	12.0	8.8	12.8	12.8	8.9	7.6	11.0	11.0
RSi007SX4_	7.0	5.5	10.0	6.7	15.0	12.8	16.3	16.3	12.0	11.0	14.0	14.0
RSi010SX4_	10.0	7.5	10.0	7.5	19.7	16.3	19.7	16.3	15.6	14.0	15.6	14.0
RSi015SX4_	15.0	11.0	20.0	13.0	30.9	25.8	33.3	33.3	23.0	21.0	27.0	27.0
RSi020SX4_	20.0	15.0	20.0	15.0	40.0	33.3	40.0	33.3	31.0	27.0	31.0	27.0
RSi025SX4_	25.0	18.5	30.0	20.5	46.3	40.0	47.8	47.8	37.0	34.0	40.0	40.0
RSi030SX4_	30.0	22.0	40.0	25.5	57.5	47.8	62.4	62.4	43.0	40.0	52.0	52.0
RSi040SX4_*	40.0	30.0	50.0	33.9	62.8	53.3	65.0	65.0	61.0	52.0	65.0	65.0
RSi050SX4_*	50.0	37.0	60.0	40.3	71.0	65.0	77.0	77.0	71.0	65.0	77.0	77.0
RSi060SX4_*	60.0	45.0	75.0	50.3	86.0	77.0	96.0	96.0	86.0	77.0	96.0	96.0
RSi075SX4_*	75.0	55.0	82.0	55.0	105.0	96.0	105.0	105.0	105.0	96.0	105.0	105.0
RSi100SX4D*	100.0	75.0	125.0	90.0	140.0	124.0	168.0	156.0	140.0	124.0	168.0	156.0
RSi125SX4D*	125.0	90.0	150.0	112.5	168.0	156.0	205.0	180.0	168.0	156.0	205.0	180.0
RSi150SX4D*	150.0	112.5	200.0	150.0	205.0	180.0	240.0	240.0	205.0	180.0	240.0	240.0

* Models 40HP and above have DC Link choke.

POWER AND CURRENT RATINGS

Table 4: Ratings for Three-Phase 600 +10 / -15% Models

Model Number	Motor Power				Input Current (A)		Output Current (A)	
	Constant Torque (HP)	Constant Torque (kW)	Variable Torque (HP)	Variable Torque (kW)	Constant Torque (FLA)	Variable Torque (FLA)	Constant Torque (FLA)	Variable Torque (FLA)
					600VAC	600VAC	600VAC	600VAC
RSi001SX6_	1.0	0.75	1.5	1.1	2.0	3.1	1.7	2.3
RSi002SX6_	2.0	1.5	2.0	1.5	3.6	3.6	2.7	2.7
RSi003SX6_	3.0	2.2	5.0	4.0	5.0	6.8	3.9	5.3
RSi005SX6_	5.0	4.0	5.0	4.0	7.6	7.6	6.1	6.1
RSi007SX6_	7.5	5.5	10.0	7.5	10.4	14.1	9.0	11.0
RSi010SX6_	10.0	7.5	10.0	7.5	14.1	14.1	11.0	11.0
RSi015SX6_	15.0	10.0	20.0	15.0	20.8	27.8	17.0	22.0
RSi020SX6_	20.0	15.0	25.0	18.5	27.8	33.4	22.0	27.0
RSi025SX6_	25.0	18.5	30.0	22.0	33.4	39.1	27.0	32.0
RSi030SX6_	30.0	22.0	30.0	22.0	39.1	39.1	32.0	32.0
RSi040SX6_	40.0	30.0	50.0	37.0	52.0	65.2	41.0	52.0
RSi050SX6_*	50.0	37.0	60.0	45.0	52.0	62.0	52.0	62.0
RSi060SX6_*	60.0	45.0	75.0	55.0	62.0	77.0	62.0	77.0
RSi075SX6_*	75.0	55.0	100.0	75.0	77.0	99.0	77.0	99.0
RSi100SX6D*	100.0	75.0	125.0	90.0	99.0	125.0	99.0	125.0
RSi125SX6D*	125.0	90.0	150.0	112.5	125.0	144.0	125.0	144.0
RSi150SX6D*	150.0	112.5	200.0	150.0	144.0	192.0	144.0	192.0

* Models 50HP and above have DC Link choke.

CONTROL FEATURES

Table 5

A1 reference input	0 to 5VDC, 0 to 10VDC, ±10VDC 0/4 to 20mA (50Ω or 250Ω load)
A2 Reference Input / Pulse Train Input	0 to 5VDC, 0 to 10VDC, 0/4 to 20mA (250Ω load) or up to 100kHz pulse train
Reference Supply Voltage	10VDC (10mA maximum)
Digital Inputs	Low Level 0-3V (OFF), High Level 10-30V (ON) Pull Down Logic 3mA, Pull Up Logic 1.5mA.
Digital Supply Output	24VDC (Up to 200mA maximum depending on other options)
Preset Frequencies	3 inputs for seven preset frequencies (selectable)
Control Output	2 SPDT relay outputs - 130VAC, 1A / 250VAC, 0.5A 3 open collector outputs (rated up to 90mA, 40VDC per device) 1 programmable pulse train with output proportional to frequency
Analog Output	1 voltage, 0 to 10VDC (2mA maximum) 1 current, 0/4 to 20mA
Pulse Train Output	Pulse train is proportional to output frequency and programmable to either 6, 48, 96, or 3072 x the operating frequency of the drive.
DC Injection Braking	Off or on with adjustable current (0 to 150%), adjustable time (0 to 60s or continuous), activation by terminal strip or by frequency of the drive.
Torque Limit	Off or on, adjustable voltage from 5 to 150% May be enabled on start cycle or on start/reference change.
Current Limit	Adjustable 1-200% constant torque, 1-150% variable torque.
Speed Ramps	Primary, two Alternates and Jog - 0.1 to 3200s. May be selected on DI, start/stop or direction change.
Voltage Boost	Adjustable 0 to 30% or auto-boost
Voltage Characteristic	Linear 2-piece or Linear Quadratic
Timed Overload	Off or on, adjustable inverse time trip, 15 to 110% of rated output for 10:1 or 2:1 speed range motors
Non-Defeatable Protective Features	Overcurrent, overvoltage, overtemperature, ground fault, short circuit, dynamic brake overload.
Defeatable Protective Features	Phase loss, timed overload, undervoltage, external fault, broken wire, loss of reference.

ENVIRONMENTAL

Table 6

Operating temperature	0°C to +40°C (32°F to 104°F)[1]
Storage temperature	–20°C to +65°C (-4°F to 149°F)
Maximum heatsink temperature	100°C (212°F)
Humidity	0% to 95% non-condensing
Altitude	1000m (3300ft) without derating
Maximum vibration	5.9m/s^2 (19.2 ft/s^2) [0.6G]
Acoustic noise	80DBA sound power at 1m (3ft)
Cooling	Natural convection: 1 and 2HP model Forced air: 3 to 150HP NEMA 1 / IP31 and NEMA 12 / IP55 models

[1] On NEMA 1 / IP31 models with conduit plate removed, the operating temperature is 0°C to + 55°C (32°F to 131°F) for 230 and 460VAC models and 0°C to +50°C (32°F to 122°F) for 600VAC models up to 75HP. See section 3.5.1 on page 21 for further information.

ELECTRICAL

Table 7

Voltage input	RSihhhSX2_ models: 200 to 230VAC, 3 Phase, ±15% RSihhhSX4_ models: 380 to 460VAC, 3 Phase, ±15% RSihhhSX6_ models: 600VAC, 3 Phase, +10%, -15%		
Line frequency	50 / 60Hz ± 2Hz		
DC bus voltage for:	RSihhhSX2_ Models	RSihhhSX4_ Models	RSihhhSX6_ Models
Overvoltage trip	407VDC	814VDC	1017VDC
Dynamic Brake activation	391VDC	782VDC	973VDC
Nominal undervoltage (UV) trip	202VDC	404VDC	505VDC
Control system	Voltage Vector pulse width modulation (PWM) Carrier frequency = 1 to 16kHz in 0.1kHz steps (Factory Default 2.2kHz)		
Output voltage	0 to 100% of line voltage		
Overload capacity	CT - 150% of rated RMS for 60 seconds (VT - 110% for 60 seconds), 250% Instantaneous overcurrent,		
Starting Torque	Up to 200% of nominal torque (motor dependent)		
Starting Current	Up to 250% of drive rating for 20s if the output frequency is less than 30Hz.		
Rated output frequency	50/60Hz ±5%		
Frequency range	0.1 to 320Hz		
Frequency stability	0.01Hz (digital), 0.1% (analog) over 24h ±10°C change		
Frequency setting	By keypad, by external signal (0 to 10VDC, 0 to 20mA, 4 to 20mA, or ±10VDC), or by a pulse train up to 100kHz		
Agency listing	UL and cUL Listed, CE marked		

hhh = horsepower rating of drive

ALTITUDE DERATING

2.1 Altitude Derating

Benshaw VFDs are capable of operating at altitudes up to 3,300 feet (1000 meters) without requiring an altitude derate. Table 8 provides the derating percentage to be considered when using a drive above 3,300 feet (1000 meters).

Table 8: Altitude Derating

Altitude		Percent Derating (Amps)
3,300 feet	1,006 meters	0.0%
4,300 feet	1,311 meters	3.0%
5,300 feet	1,615 meters	6.0%
6,300 feet	1,920 meters	9.0%
7,300 feet	2,225 meters	12.0%
8,300 feet	2,530 meters	15.0%
9,300 feet	2,835 meters	18.0%

THERMAL DERATING

2.2 Thermal Derating

- NEMA12 - 0-40°C
- NEMA 1 - 0-40°C
- NEMA 1 (IP21) without conduit plate - 0-55°C 230/460V
  - 0-50°C 600V
- Size 6 NEMA 12 without conduit plate and front covers - 0-50°C

⌘ **NOTE:** For derating above 10,000ft consult Benshaw.

Notes:

3 Installation

PRELIMINARY INSPECTION

3.1 Preliminary Inspection

Before storing or installing the RSi SX drive, thoroughly inspect the device for possible shipping damage. Upon receipt:

- Remove the drive from its package and inspect exterior for shipping damage. If damage is apparent, notify the shipping agent and your sales representative.
- Remove the cover and inspect the drive for any apparent damage or foreign objects. Ensure that all mounting hardware and terminal connection hardware is properly seated, securely fastened, and undamaged.
- Read the technical data label affixed to the drive and ensure that the correct horsepower and input voltage for the application has been purchased. The numbering system for a Benshaw inverter is shown on page 5.
- If you will store the drive after receipt, place it in its original packaging and store in a clean, dry place free from direct sunlight or corrosive fumes, where the ambient temperature is not less than -20°C(-4°F) or greater than +65°C (+149°F).

CAUTION

EQUIPMENT DAMAGE HAZARD
Do not operate or install any drive that appears damaged.
Failure to observe this instruction can result in injury or equipment damage.

ATTENTION

RISQUE DE DOMMAGES MATÉRIELS
Ne faites pas fonctionner et n'installez pas tout variateur de vitesse qui semble être endommagé.
Si cette directive n'qest pas respectée, cela peut entraîner des blessures corporelles ou des dommages matériels.

ENVIRONMENTAL CONDITIONS

3.2 Environmental Conditions

- Do not install the drive in a place subjected to high temperature, high humidity, excessive vibration, corrosive gases or liquid, or airborne dust or metallic particles.
- Do not mount the drive near heat-radiating elements or in direct sunlight.
- Verify the ambient condition of the mounting location. Ambient temperature should not be below -20°C (-4°F) and must not exceed +65°C (+149°F). Relative humidity should be less than 95% (non-condensing). The altitude should be below 3,300ft (1,000m) without derating.

3.3 Installation Precautions

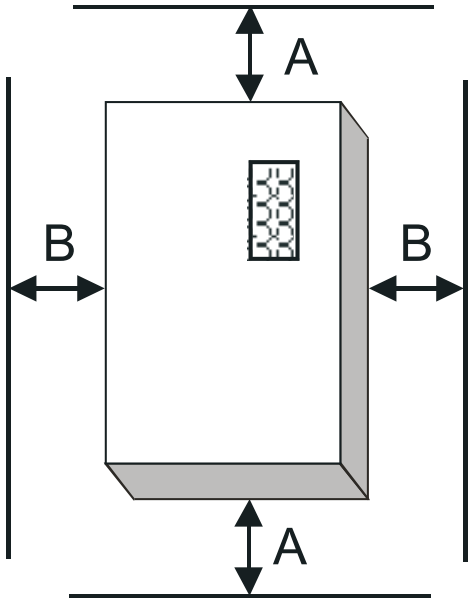
Improper installation of the RSi SX drive will greatly reduce its life. Be sure to observe the following precautions when selecting a mounting location. **Failure to observe these precautions may void the warranty!**

- Mount the drive vertically and do not restrict the air flow to the heat sink fins.
- **When installing next to other equipment, ensure that there is a clearance space of at least 8 inches (20cm) from the top and bottom of the unit to the adjacent unit. Any ventillation requirements for the adjacent equipment must also be added. There should be at least 2 inches (5cm) on either side of the unit to the adjacent unit. For the models below 50HP the top and bottom clearance specifications may be reduced to 4 inches (10cm). This space ensures that adequate ventilation is provided.**

Figure 2: Ventilation Dimensions

A = 1-20HP, 4”
25HP & up, 5”

B = 1-20HP-3”
25HP & up, 2”



⌘ **NOTE:**
1 to 20HP - Air is drawn in from the sides and exhausted through top and bottom. Ensure wire tray for conduit does not block air flow.

⌘ **NOTE:**
These are the minimum ventilation requirements for a single unit. If units are installed in close proximity, dimensions A and B must be doubled to allow proper air ventilation.

⌘ **NOTE:** Ensure that the ventilation openings are not obstructed.

3.4 Considerations for Mounting NEMA 1 / IP31 in Host Enclosures

NEMA 1 / IP31 models may be used in an expanded ambient temperature range if the conduit plate on the bottom of the unit is removed. Once the conduit plate is removed, 230 and 460VAC models may be used where ambient temperatures range from 0 to 55°C (32 to 131°F), while 600VAC models may be used where ambient temperatures range from 0 to 50°C (32 to 122°F).

The RSi SX Sensorless Vector Drive is available from stock in a variety of enclosures that meet the requirements of almost any application. Yet, special applications (such as use in washdown environments or in integrated systems) may make it desirable to mount RSi SX drives in a host enclosure.

When RSi SX drives are mounted in a host enclosure the heat dissipated by the drives must be dissipated by the host enclosure. If this is not accomplished, the control circuitry of the RSi SX drives will be damaged.

Two techniques are available for mounting RSi SX drives in a host enclosure:
- The drives may be entirely enclosed in the host enclosure; or
- The drives may be mounted with their cooling fins outside of the host enclosure.

The following sections discuss these two mounting techniques in greater detail.

3.4.1 NEMA 1 / IP31 Models Entirely Enclosed in the Host Enclosure

When an RSi SX drive is entirely enclosed in a host enclosure, the host enclosure must be properly sized to dissipate the heat generated by the drive and any other power-dissipating devices also mounted in the host enclosure. Tables 9, 10, and 11 on pages 19 , 19, and 20 provide the heat dissipated by the various models of RSi SX drives at various switching frequencies. Use this information to adequately size the host enclosure.

The drive's ambient temperature rating can be increased when placed inside a host enclosure by removing the conduit plate (*see Section 3.5.1 on page 21 for more details*).

3.4.2 NEMA 1 / IP31 Models with Fins External to the Host Enclosure

By mounting an RSi SX drive so that its heatsink fins are outside of the host enclosure, you may select a smaller host enclosure than that required when the drive is mounted entirely inside the host enclosure. For most applications with this type of mounting, typically you will not need such additional cooling devices as fans, heat exchangers, or air conditioners.

The amount by which the load on the host enclosure is reduced is the Watts dissipated by the heatsink of the drive. Table 12 on page 20 shows the Watts dissipated by each RSi SX model after deducting the amount of heat dissipated by the heatsinks of the model. Use the values shown in the table to adequately size the host enclosure (*refer to the Fins Out Kit option on page 75.*)

HEAT DISSIPATION

Table 9: Heat Dissipation for Models Entirely Inside an Enclosure at 200 - 230VAC

RSi SX Model	Carrier Frequency			Max. Carrier Frequency for Rated Current (kHz)
	Watts Dissipated at 4kHz	Watts Dissipated at 7kHz	Watts Dissipated at 10kHz	
RSi001SX2S_	37	44	51	10
RSi002SX2S_	59	71	81	10
RSi003SX2S_	77	92	106	10
RSi001SX2_	37	44	51	10
RSi002SX2_	59	71	81	10
RSi003SX2_	77	92	106	10
RSi005SX2_	112	135	156	10
RSi007SX2_	162	212	220	10
RSi010SX2_	195	251	-	6
RSi015SX2_	267	312	354[1]	9
RSi020SX2_	276	361	-	7
RSi025SX2_	597	655	676[1]	8
RSi030SX2_	642	685[1]	-	5

[1] Dissipation at rated current and maximum switching frequency.

Table 10: Heat Dissipation for Models Entirely Inside an Enclosure at 380 - 460VAC

RSi SX Model	Carrier Frequency			Max. Carrier Frequency for Rated Current (kHz)
	Watts Dissipated at 4kHz	Watts Dissipated at 7kHz	Watts Dissipated at 10kHz	
RSi001SX4_	33	43	53	10
RSi002SX4_	52	69	84	10
RSi003SX4_	68	90	110	10
RSi005SX4_	99	131	161	10
RSi007SX4_	112	144	174	10
RSi010SX4_	139	180	217	10
RSi015SX4_	170	210	255[1]	9
RSi020SX4_	200	245[1]	-	5
RSi025SX4_	280	383	-	7
RSi030SX4_	335	371[1]	-	5
RSi040SX4_	398	-	-	2.5
RSi050SX4_	600	670[1]	-	5
RSi060SX4_	710	-	-	4
RSi075SX4_	720	-	-	2
RSi100SX4D	1330	1697	-	7
RSi125SX4D	1556	1797[2]	-	5
RSi150SX4D	1862[3]	-	-	3

[1] Dissipation at rated current and maximum switching frequency.
[2] Rated watt loss at 5kHz carrier.
[3] Rated watt loss at 3kHz carrier.

HEAT DISSIPATION

Table 11: Heat Dissipation for Models Entirely Inside an Enclosure at 600VAC

RSi SX Model	Carrier Frequency			Max. Carrier Frequency for Rated Current (kHz)
	Watts Dissipated at 4kHz	Watts Dissipated at 7kHz	Watts Dissipated at 10kHz	
RSi001SX6_	40	52	64	10
RSi002SX6_	62	83	101	10
RSi003SX6_	82	108	132	10
RSi005SX6_	85	115	155	10
RSi007SX6_	91	131	172	10
RSi010SX6_	112	160	-	8
RSi015SX6_	164	235	282[1]	9
RSi020SX6_	218	277[1]	-	6
RSi025SX6_	286	364[1]	-	6
RSi030SX6_	343	388[1]	-	5
RSi040SX6_	417	-	-	4
RSi050SX6_	700	-	-	4
RSi060SX6_	720[1]	-	-	3
RSi075SX6_	745[1]	-	-	2
RSi100SX6D	1625	-	-	4
RSi0125SX6D	1687[2]	-	-	2.5
RSi150SX6D	1745[3]	-	-	2

[1] Dissipation at rated current and maximum switching frequency.
[2] Rated watt loss at 2.5kHz carrier.
[3] Rated watt loss at 2kHz carrier.

Table 12: Heat Dissipation When Fins Are External to the Enclosure

RSi SX Model 230V	Watts Dissipated	RSi SX Model 460V	Watts Dissipated	RSi SX Model 600V	Watts Dissipated
RSi001SX2S_	19	RSi001SX4_	20	RSi001SX6_	20
RSi002SX2S_	20	RSi002SX4_	21	RSi002SX6_	21
RSi003SX2S_	27	RSi003SX4_	27	RSi003SX6_	27
RSi001SX2_	19	RSi005SX4_	30	RSi005SX6_	30
RSi002SX2_	20	RSi007SX4_	36	RSi007SX6_	33
RSi003SX2_	27	RSi010SX4_	40	RSi010SX6_	39
RSi005SX2_	29	RSi015SX4_	46	RSi015SX6_	43
RSi007SX2_	36	RSi020SX4_	50	RSi020SX6_	44
RSi010SX2_	34	RSi025SX4_	75	RSi025SX6_	73
RSi015SX2_	68	RSi030SX4_	76	RSi030SX6_	78
RSi020SX2_	73	RSi040SX4_	80	RSi040SX6_	82
RSi025SX2_	135	RSi050SX4_	134	RSi050SX6_	135
RSi030SX2_	137	RSi060SX4_	145	RSi060SX6_	143
		RSi075SX4_	150	RSi075SX6_	152
		RSi100SX4D	339	RSi100SX6D	325
		RSi125SX4D	353	RSi125SX6D	337
		RSi150SX4D	372	RSi150SX6D	349

MAINTENANCE

3.5 Maintenance / Environmental Integrity

3.5.1 Removal of the Conduit Plate on NEMA 1 / IP31 Models

NEMA 1 / IP31 models may be used in an expanded ambient temperature range if the conduit plate on the bottom of the unit is removed. Once the conduit plate is removed, 230 and 460VAC models may be used where ambient temperatures range from 0 to 55°C (32 to 131°F), while 600VAC models may be used where ambient temperatures range from 0 to 50°C (32 to 122°F).

On frame sizes 0 through 2 (1 to 10HP models; see Table 36 on page 82), to access the screws holding the conduit plate in place, you must first remove the terminal access cover. Once this cover has been taken off, unfasten the screws securing the conduit plate and detach the conduit plate to allow for additional air circulation through the unit assembly which permits operation in the expanded temperature range.

On the larger frame sizes (15 to 150HP models; see Table 36 on page 82) the screws securing the conduit plate are directly accessible from outside the unit. Simply unfasten the screws securing the conduit plate and detach the conduit plate to permit operation in the expanded temperature range.

With the removal of the conduit plate, the protection of the drive is changed to IP21, which is an IEC enclosure definition. The number 21 means the following:

2 = protection against solid foreign objects with a diameter of 12.5mm or larger
1 = protection against vertically falling particals or water drops.

3.5.2 Minimum Torque Values to Secure Cover

If you remove the cover of an IP55/NEMA 12 RSi SX drive (models D), it is imperative that the cover be re-secured with an air tight seal. Table 13 specifies the torque values for the bolts that secure the covers on the various RSi SX models.

Table 13: RSi SX Model Torque Values

RSi SX Enclosure Type		Torque Value	
		English	Metric
NEMA 12 / IP55	1-10HP, 230VAC input	18 in-lbs	2.03Nm
	15-30HP, 230VAC input	12 in-lbs	1.35Nm
	1-20HP, 460 and 600VAC input	18 in-lbs	2.03Nm
	25-150HP, 460 and 600VAC input	12 in-lbs	1.35Nm

3.5.3 NEMA 12/IP55 Kit

The SX product line is designed as both a NEMA 1 and 12 enclosure rating. The NEMA 12 rating is obtained by installing the NEMA 12 kit.

The NEMA 12 kit is designed to close the vents of the NEMA 1 SXdrive enclosure. 1-75HP SX drives are manufactured as NEMA 1, but with the required NEMA 12 gaskets in place. The reason for the vents to be left open is to allow a higher ambient temperature ratings when the drive is installed in another enclosure. This is accomplished by removing the conduit plate with the vent OPEN. If the drive is to be placed directly in an environment that requires a NEMA 12 enclosure rating, the NEMA 12 kit can be installed at the factory or in the field.

3.5.4 Description of the NEMA 12 Kit

The NEMA 12 kit consists of two pieces of polycarbonate overlays with pre-applied adhesive specifically designed to adhere to the surfaces the kit is to be installed on, either polycarbonate or steal that is powder coat painted.

A product label is included in the kit, it is to be affexed next to the product tech label, located at the top of the drive enclosure. This label identifies that the NEMA 1 enclosure has been changed to meet the requirements of a NEMA 12 enclosure. The RSiS1SXN12 Kit contains 2 sets of overlays, due ro the enclosure differences.

3.5.5 NEMA 12 KITS

There are different kits depending on the size of the drive.

Table 14

NEMA 12 Kit	Frame Size	Model 230V	Model 460V	Model 600V
RSi S0&1 SX N12	Size 0	RSi001SX2S	RSi001SX4	
		RSi002SX2S	RSi002SX4	
		RSi001SX2		
		RSi002SX2		
RSi S0&1 SX N12	Size 1			RSi001SX6
		RSi003SX2S		RSi002SX6
		RSi003SX2	RSi003SX4	RSi003SX6
		RSi005SX2	RSi005SX4	RSi005SX6
RSi S2 SX N12	Size 2	RSi007SX2	RSi007SX4	RSi007SX6
		RSi010SX2	RSi010SX4	RSi010SX6
RSi S3 SX N12	Size 3		RSi015SX4	RSi015SX6
			RSi020SX4	RSi020SX6
RSi S4 SX N12	Size 4	RSi015SX2	RSi025SX4	RSi025SX6
		RSi020SX2	RSi030SX4	RSi030SX6
			RSi040SX4	RSi040SX6
RSi S5 SX N12	Size 5	RSi025SX2	RSi050SX4	RSi050SX6
		RSi030SX2	RSi060SX4	RSi060SX6
		RSi040SX2	RSi075SX4	RSi075SX6

Size 6 drive, 100-150/200 HP is only available as a NEMA 12 drive. By removing the conduit plate and the bottom door, that maintains the IP21 protection level.

4 Connections

CONNECTION PRECAUTIONS

DANGER

HAZARDOUS VOLTAGE

- Read and understand this manual in its entirety before installing or operating the RSi SX Sensorless Vector Drive. Installation, adjustment, repair, and maintenance of these drives must be performed by qualified personnel.
- Disconnect all power before servicing the drive. **WAIT 5 MINUTES** until the DC bus capacitors discharge. Then measure the DC bus capacitor charge between the B+ and B– terminals to verify that the DC voltage is less than 45VDC. **The DC Bus LED is not a definitive indication of the absence of DC voltage.**
- DO NOT short across DC bus capacitors or touch unshielded components or terminal strip screw connections with voltage present.
- Install all covers and close door before applying power or starting and stopping the drive.
- The user is responsible for conforming to all applicable code requirements with respect to grounding all equipment.
- Many parts in this drive, including printed circuit boards, operate at line voltage. **DO NOT TOUCH**. Use only electrically-insulated tools.

Before servicing the electrical system:

- Disconnect all power.
- Place a “DO NOT TURN ON” label on the drive disconnect.
- Lock the disconnect in the open position.

Failure to observe these precautions will cause shock or burn, resulting in severe personal injury or death.

DANGER

TENSION ELECTRIQUE DANGEREUSE

- Lisez et comprenez ces directives dans leurs intégralité avant d’installer ou de faire fonctionner le variateur de vitesse Sensorless Vector Drive RSi SX. L’installation, le réglage, les réparations et l’entretien des ces variateurs de vitesse doivent être effectuées par du personnel qualifié.
- Coupez toutes les alimentations avant de travailler sur le variateur de vitesse. **ATTENDEZ CINQ MINUTE** pour que la décharge des condensateurs du bus cc s’effectue. Ensuite, mesurez la tension des condensateurs du bus cc entre les bornes B+ et B–, afin de vérifier que la tension cc soit inférieure à 45VDC. **La DÉL du bus cc ne fournit pas une indication définitive de l’absence de tension cc.**
- NE court-cuitez PAS les condensateurs du bus cc ou ne touchez pas aux composantes non blindées ou aux connexions des vis du bornier si l’appareil est sous tension.
- Installez tous les couvercles et fermez la porte avant de mettre le variateur de vitesse sous tension, de le mettre en marche ou de l’arrêter.
- L’utilisateur est responsable de la conformité avec tous les codes électriques en vigueur concernant la mise à la terre de tous les appareils.
- De nombreuses pièces de ce variateur de vitesse, y compris les cartes de circuits imprimés, fonctionnent à la tension du secteur. **N’Y TOUCHEZ PAS**. N’utilisez que des outils dotés d’une isolation électrique.

Avant tout entretien ou réparation sur le variateur de vitesse:

- Coupez toutes les alimentations.
- Placez une étiquette «NE PAS METTRE SOUS TENSION» sur le sectionneur du variateur de vitesse.
- Verrouillez le sectionneur en position ouverte.

Si ces précautions ne sont pas respectées, cela causera une électrocution ou des brûlures, ce qui entraînera des blessures graves ou la mort.

GENERAL WIRING INFORMATION

4.1 General Wiring Information

4.1.1 Wiring Practices

When making power and control connections, the following should be observed:

- Never connect input AC power to the motor output terminals T1/U, T2/V, or T3/W as damage to the drive will result.
- Power wiring to the motor must have the maximum possible separation from all other power wiring. Do not run in the same conduit; this separation reduces the possibility of coupling electrical noise between circuits.
- Cross wires at right angles whenever power and control wiring cross.
- Good wiring practice also requires separation of control circuit wiring from all power wiring. Since power delivered from the drive contains high frequencies which may cause interference with other equipment, do not run control wires in the same conduit or raceway with power or motor wiring.

⌘ **NOTE:** Local electrical codes must be adhered to for all wiring practices.

4.1.2 Considerations for Control Wiring

Control wiring refers to the wires connected to the control terminal strip. Select control wiring as follows:

- Shielded wire is recommended to prevent electrical noise interference from causing improper operation or nuisance tripping.
- Use only UL or CSA recognized wire.
- Control wire voltage rating must be at least 300V for 230V systems.

4.1.3 Considerations for Power Wiring

Power wiring refers to the line and load connections made to terminals L1/R, L2/S, L3/T, and T1/U, T2/V, T3/W respectively. Select power wiring as follows:

- Use only UL or CSA recognized wire.
- Wire voltage rating must be a minimum of 300V for 230VAC systems and 600V (Class 1 wire) 460VAC and 600VAC systems.
- Use line disconnect in conjunction with fuses on the incoming power lines.
- Grounding must be in accordance with NEC and CEC. If multiple RSi SX drives are installed near each other, each must be connected to ground. Take care to not form a ground loop.
- Wire must be made of copper and rated 60/75°C (unless otherwise specified in the wire gauges table). Refer to Table 15 on page 26 for recommended wire gauges and temperature ratings.

Table 15: Recommended Wire Gauges

Model	208VAC		230VAC		Model	CT 460VAC		VT 460VAC		Model	CT 600VAC		VT 600VAC	
	AWG	mm²	AWG	mm²		AWG	mm²	AWG	mm²		AWG	mm²	AWG	mm²
RSi001SX2S_	14	2.5	14	2.5	RSi001SX4_	14	2.5	14	2.5	RSi001SX6_	14	2.5	14	2.5
RSi002SX2S_	12	4.0	12	4.0	RSi002SX4_	14	2.5	14	2.5	RSi002SX6_	14	2.5	14	2.5
RSi003SX2S_	10	6.0	10	6.0	RSi003SX4_	14	2.5	14	2.5	RSi003SX6_	14	2.5	14	2.5
RSi001SX2_	14	2.5	14	2.5	RSi005SX4_	14	2.5	12	4.0	RSi005SX6_	14	2.5	14	2.5
RSi002SX2_	14	2.5	14	2.5	RSi007SX4_	12	4.0	12	4.0	RSi007SX6_	14	2.5	12	4.0
RSi003SX2_	12	4.0	14	2.5	RSi010SX4_	12	4.0	na		RSi010SX6_	12	4.0	10	6.0
RSi005SX2_	10	6.0	10	6.0	RSi015SX4_	10	6.0	10	6.0	RSi015SX6_	10	6.0	10	6.0
RSi007SX2_	8	10.0	8	10.0	RSi020SX4_	10[1]	6.0[1]	na		RSi020SX6_	8	10.0	8	10.0
RSi010SX2_	8[1]	10.0[1]	8	10.0	RSi025SX4_	8[1]	10.0[1]	6[1]	16.0	RSi025SX6_	8	10.0	8	10.0
RSi015SX2_	6[1]	16.0[1]	6[1]	16.0[1]	RSi030SX4_	6[1]	16.0[1]	6[1]	16.0	RSi030SX6_	8	10.0	6[1]	16.0
RSi020SX2_	6[1]	16.0[1]	6[1]	16.0[1]	RSi040SX4_	6[1]	16.0[1]	3[1]	35.0	RSi040SX6_	6[1]	16.0[1]	3[1]	35.0
RSi025SX2_	2/0	35.0	3/0	35.0	RSi050SX4_	3[1]	35.0[1]	2[1]	35.0	RSi050SX6_	3[1]	35.0[1]	2[1]	5.0
RSi030SX2_	1/0	50.0	2/0	35.0	RSi060SX4_	2[1]	35.0[1]	1[1]	50.0	RSi060SX6_	2[1]	35.0[1]	1[1]	50.0
					RSi075SX4_	1[1]	50.0[1]	2/0		RSi075SX6_	1[1]	50.0[1]	1/0	
					RSi100SX4D	3/0		4/0		RSi100SX6D	1/0		2/0	
					RSi125SX4D	4/0		250		RSi125SX6D	2/0		3/0	
					RSi150SX4D	300		350[1]		RSi150SX6D	3/0		300	

[1] Use wire rated 90°C in an environment where the ambient temperature is greater than 40°C (104°F).

⌘ **NOTE:** For conduit installations, based on NEC table 310-16 ambient temperature of drive at 40°C.

4.2 Input Line Requirements

4.2.1 Line Voltage

See the Power and Current Ratings tables on page 8, 9, 10 and for the allowable fluctuation of AC line voltage for your particular RSi SX model. A supply voltage above or below the limits given in the table will cause the drive to trip with either an overvoltage or undervoltage fault.

When supplying line voltages other than the factory default values (either 230VAC, 460VAC, or 600VAC depending on the model), set the AFN 15 parameter (Supply Voltage, *see Parameter Configuration Manual*) to the appropriate value.

Exercise caution when applying the RSi SX drive on low-line conditions.

For example, an RSi SX Series VFD will operate properly on a 208VAC line - but the maximum output voltage will be limited to 208VAC. Now if a motor rated for 230VAC line voltage is controlled by this drive, higher motor currents and increased heating will result.

Therefore, ensure that the voltage rating of the motor matches the applied line voltage. If other than 60Hz output is desired, proper V/Hz can be programmed into the RSi SX drive by setting FUN 02 (Nom Mtr Voltage) and AFN 01 (Nom Mtr Freq) parameters (*see Parameter Configuration Manual for more information*).

4.2.2 Line Capacity

If the source of AC power to the RSi SX drive is greater than 10 times the kVA rating of the drive shown in Table 16, an isolation transformer or line reactor is recommended. Consult the factory for assistance in sizing the reactor.

Table 16: Transformer Sizing for RSi SX Sensorless Drive

Drive HP	1	2	3	5	7.5	10	15
Transformer kVA	2	4	5	9	13	18	23
Drive HP	20	25	30	40	50	60	75
Transformer kVA	28	36	42	56	76	90	112
Drive HP	100	125	150				
Transformer kVA	150	180	220				

⌘ **NOTE:** RSi SX Drives are suitable for use on a circuit capable of delivering more than 2500 rms symmetrical Amperes at 10% above the maximum rated voltage.

4.2.3 Use of Isolation Transformers and Line Reactors

In nearly all cases, the RSi SX drive may be connected directly to a power source. However, in the following cases, a properly-sized isolation transformer or line reactor should be utilized to minimize the risk of drive malfunction or damage:

- When the line capacity exceeds the ratings of the drive (*see Section 4.2.2).*
- When power factor correction capacitors are used on the drive's power source.
- When the power source experiences transient power interruptions or voltage spikes.
- When the power source supplying the drive also supplies large devices (such as DC drives) that contain controlled rectifiers.

4.2.4 Phase Imbalance

Phase voltage imbalance of the input AC source can cause imbalanced currents excessive heat in the drive's input rectifier diodes and DC bus capacitors. Phase imbalance can also damage motors running directly across the line.

CAUTION

EQUIPMENT DAMAGE HAZARD
Never use power-factor correction capacitors on motor terminals T1/U, T2/V, or T3/W of the RSi SX Sensorless Vector Drive. Doing so will damage the semiconductors.

Failure to observe this instruction can result in injury or equipment damage.

ATTENTION

RISQUE DE DOMMAGES MATÉRIELS
Ne raccordez jamais de condensateurs de correction du facteur de puissance aux bornes T1/U, T2/V, ou T3/W du moteur du variateur de vitesse Sensorless Vector Drive RSi SX. Car cela endommagera les semiconducteurs.

Si cette directive n'qest pas respectée, cela peut entraîner des blessures corporelles ou des dommages matériels.

4.2.5 Motor Lead Length Specifications

Adhere to the NEC / CEC and any local codes during the installation of VFD and motor systems. Excessive lead lengths may adversely effect the performance of the motor. Special cables are not required. Lead lengths from VFD to the motor in excess of those listed in Table 17 may require filters to be added to the output of the VFD. Table 17 lists the suggested maximum lead lengths for the listed motor types.

The voltage of the pulses can be almost double at the motor terminals, depending on the motor cable properties. This in turn can cause additional stress of the motor insulation. **The motor manufacturer should be consulted regarding the construction of the motor insulation**. Failure of the motor to fulfill the following requirements may shorten its life.

Table 17: Lead Length Specifications

Model	PWM Carrier Frequency	Suggested Maximum Lead Distance
230 Volt	All	1000 feet
460 Volt	≤ 5kHz	600 feet
	> 5kHz	300 feet
600 Volt	≤ 5kHz	200 feet
	> 5kHz	100 feet

⌘ **NOTE**: Contact Benshaw Inc. for application assistance when using lengths in excess of those listed. Exceeding the peak voltage rating or the allowable thermal rise time of the motor insulation will reduce the life expectancy of the motor.

4.2.6 Considerations for Motor Lead Lengths

When selecting the distance from the RSi SX drive to the motor, the following considerations should be kept in mind:

- If the leads for the motor connections exceed Table 17, the motor windings may be subjected to voltage stresses two or three times nominal values unless an output filter is utilized. Consult with motor manufacturer to ensure compatibility.
- When the leads for the motor connections exceed Table 17, expected motor life may be diminished. Consult with Benshaw Inc. for recommendations in this case.

POWER TERMINALS

4.3 Terminals Found on the RSi SX Power Board

Figure 3: RSi SX Power Terminals (1-20HP, 230V; 1-40HP, 460/600V)

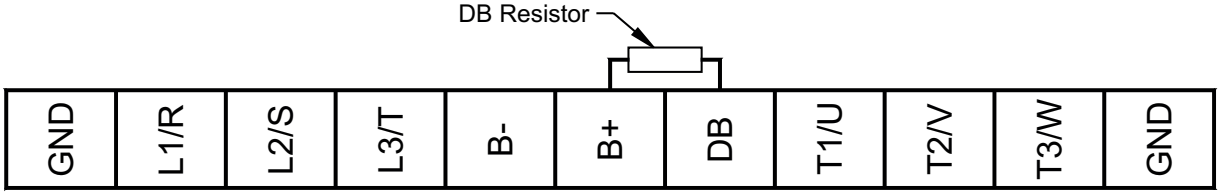


Figure 4: RSi SX Power Terminals (25-30HP, 230V; 50-75HP, 460/600V)

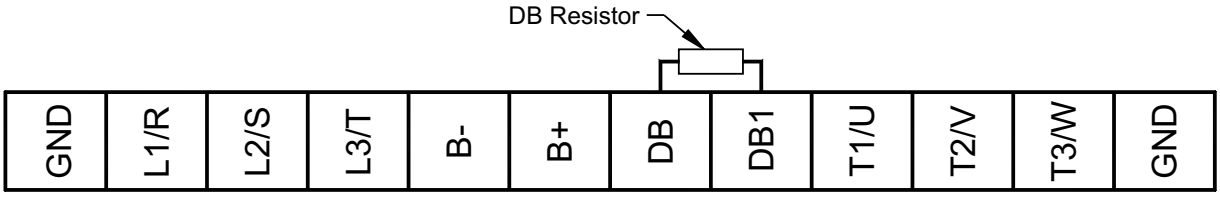
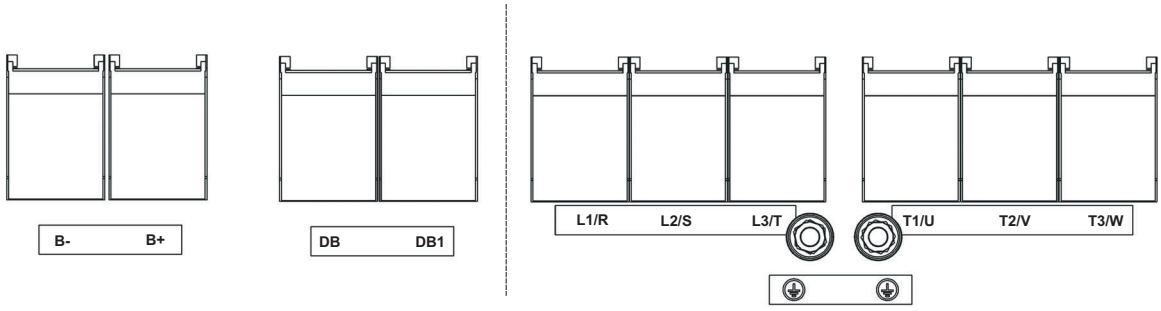


Figure 5: RSi SX Power Terminals (100-150HP CT, 460/600V)



4.3.1 Power Terminals

Figures 3 and 4 show the power terminals for the RSi SX drive. Table 18 describes the terminals.

Table 18: Description of RSi SX Power Terminals

Terminal	Description
GND	Earth ground.
L1/R L2/S L3/T	These terminals are the line connections for three-phase models. (Single-phase models will only have the L1/R terminal, with the other two terminals being replaced by a terminal labeled N.)
B- B+	The B-/B+ terminals provide a connection to the DC Bus. They may be used for common DC Bus connections or for powering the drive from a DC source. (If the drive is powered from a DC source, disable phase failure detection by setting parameter Input Phase Flt to disabled; see page 33 for more information.)
DB/B+ -or- DB/DB1	The DB/B+ terminals or DB/DB1 terminals (depending on the model[1]) are the connection points for the dynamic brake resistor. If an external resistor is used for dynamic braking, the internal resistor must be disconnected; see page 33 for more information.
T1/U T2/V T3/W	These terminals are for motor connections.

1 The sixth terminal from the left is labeled "B+" on 230 VAC models of 20HP or less (models RSi001SX2S_ to RSi003SX2S_ and RSi001SX2_ to RSi020SX2_) as well as 460VAC and 600VAC models of 40HP or less (models RSi001SX4_ to RSi040SX4_ and RSi001SX6_ to RSi040SX6_). On the remaining, larger-horsepower models, this terminal is labeld "DB1." The function of the terminal does not change.

4.3.2 Typical Power Connections

Figures 3 and 4 on page 29 show the terminal connections for line power and motor output. See section 4.2 starting on page 27 for input line requirements.

Note that when testing for a ground fault, do not short any motor lead (T1/U, T2/V, or T3/W) back to an input phase (L1/R, L2/S, or L3/T).

As shown in Figures 3 and 4 on page 29, it is necessary to provide fuses and a disconnect switch for the input AC line in accordance with all applicable electrical codes. The RSi SX drive is able to withstand a 150% overload for 60s.

For maximum protection of the drive, size the input fuses based upon the input current for your particular configuration (see Tables 20, 21, and 22 found on the pages 31 through 32). Select the fuse based upon 125% of the listed current and round your result to the next higher standard value. The recommended supplier is Bussman JJS or JJN type fuses or Ferraz-Shawmut A6T/A3T type fuses (depending on fuse voltage rating). For current ratings up to and including 30A, KTK type fuses may be substituted.

4.3.3 Power Lugs for 100-150-200HP CT

Table 19: Recommended Lugs

Wire Size	Burndy Manufacturer Part Number
1/0	YA25-L6BOX
3/0	YA27-LBOX
4/0	YA28-LBOX
300	YA30-L
350	YA31-L

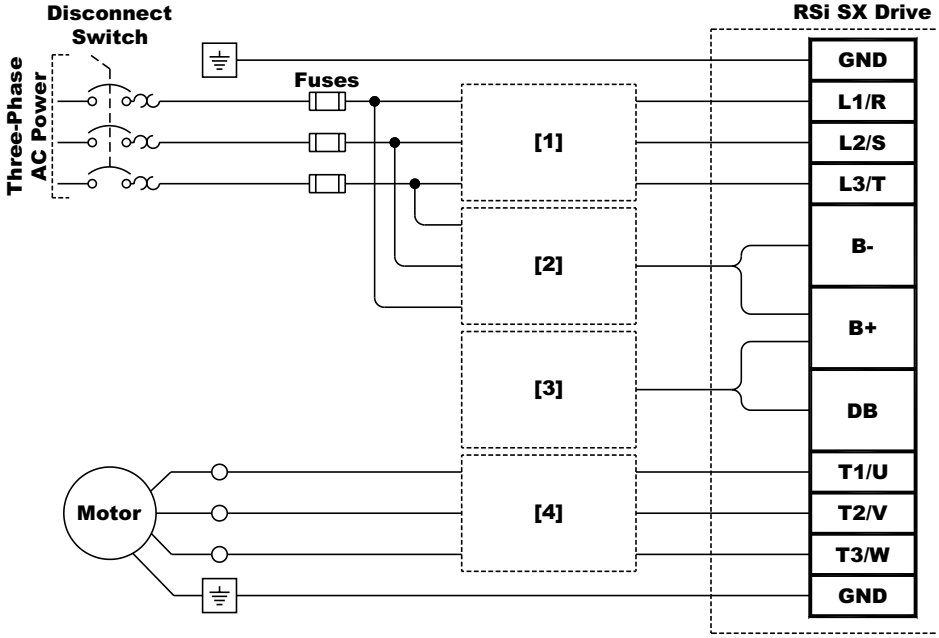
4.3.4 Hi-Pot

If you plan on adding Hi-Pot Testing, consult factory.

4.3.5 Bearing Currents

Insulated bearings and/or isolated couplings may be required due to the specific electro- mechanical nature of some systems. Extreme bearing currents may cause premature bearing failure. Consult motor supplier or Benshaw for details.

Figure 6: Connections for Power Wiring



[1] 3 or 5% Line Reactor EMI RFI Suppression Isolation Transformer Passive Filter Active Filter	[2] DC Bus Voltage - Connection for 18 pulse frontend - Multi-Drives DBR Dynamic Breaking Module Line Regeneration Module	[3] B+/DB Connection	[4] 3 or 5% Line Reactor Long Lead Filter Sine Wave Filter
⌘ **NOTE:** Refer to the Parameter Configuration Manual for more information.			

Table 20: Recommended Fuses (230VAC Models)

Model Number	Fuse Size	
	208VAC JJS/JJN[1] A6T/A3T	230VAC JJS/JJN[1] A6T/A3T
	CT/VT	CT/VT
RSi001SX2S_	15	10
RSi002SX2S_	20	20
RSi003SX2S_	30	30
RSi001SX2_	10	6
RSi002SX2_	15	10
RSi003SX2_	20	15
RSi005SX2_	30	25
RSi007SX2_	40	35
RSi010SX2_	50	40
RSi015SX2_	70	60
RSi020SX2_	70	60
[1] For sizes up to and including 30A, KTK fuses may be substituted.		

Table 21: Recommended Fuses (460VAC Models)

Model Number	Fuse Size		
	380VAC JJS/A6T	460VAC JJS/A6T	
	CT/VT	CT	VT
RSi001SX4_	6	6	6
RSi002SX4_	6	6	6
RSi003SX4_	10	10	10
RSi005SX4_	15	15	15
RSi007SX4_	20	20	20
RSi010SX4_	20	20	20
RSi015SX4_	40	35	40
RSi020SX4_	50	40	50
RSi025SX4_	60	50	60
RSi030SX4_	70	60	70
RSi040SX4_	80	70	90
RSi050SX4_	90	90	110
RSi060SX4_	110	110	150
RSi075SX4_	150	150	175
RSi100SX4D	175	175	200
RSi125SX4D	250	200	250
RSi150SX4D	300	250	300

Table 22: Recommended Fuses (600VAC Models)

Model Number	Fuse Size	
	600VAC JJS/A6T	
	CT	VT
RSi001SX6_	6	-
RSi002SX6_	6	-
RSi003SX6_	10	-
RSi005SX6_	10	-
RSi007SX6_	15	15
RSi010SX6_	20	20
RSi015SX6_	30	35
RSi020SX6_	35	50
RSi025SX6_	50	50
RSi030SX6_	50	70
RSi040SX6_	70	70
RSi050SX6_	70	80
RSi060SX6_	80	100
RSi075SX6_	100	125
RSi100SX6D	125	175
RSi125SX6D	175	200
RSi150SX6D	200	250

4.4 Dynamic Braking

The RSi SX Sensorless Vector Drive is supplied with an internal dynamic braking (DB) resistor, and is designed to have adequate dynamic braking for most applications. In cases where short stopping times or high inertia loads require additional braking capacity, two approaches may be taken:

- Purchase and install an external Benshaw DB unit; or
- Purchase and install an external resistor.

These methods are described in more detail in the following sections.

4.4.1 Benshaw's Dynamic Braking Units

One method for adding braking capacity is to purchase a Benshaw dynamic braking unit. See Tables 23 through 25.

These units allow the addition of braking capacity by utilizing off-the-shelf options. Braking capacity is added in 10HP increments, and multiple units may be connected to a single drive.

To add a DB unit to an RSi SX drive, connect it to the B+ and B- terminals and set parameter FUN 14 (DB Config) to Custom DB.

4.4.2 User-Supplied External Resistor

Rather than using a dynamic braking unit to increase braking capacity, an external resistor (supplied by the user) may be used.

The drive may be configured to protect the external resistor by entering the resistor's value, thermal resistance, and thermal capacitance into parameters FUN 15 (DB Res Value), FUN 16 (DB Rth Value), and FUN 17 (DB Cth Value). Refer to the RSi SX Parameter Configuration Manual for the default values and additional information on these parameters. The thermal specifications for the external resistor can be obtained from the resistor's manufacturer.

To use an external resistor, first disconnect the internal DB resistor and properly terminate the wires leading to it. Then, connect the external resistor to the B+ and DB or DB and DB1 terminals. Finally, set parameter FUN 14 (DB Config) to External DBR and configure the FUN 15 (DB Res Value), FUN 16 (DB Rth Value), and FUN 17 (DB Cth Value) parameters for the external resistor used.

DYNAMIC BRAKING

4.4.3 Internal and Recommended Dynamic Braking Resistor

Table 23: Internal and Recommended DBR For 230VAC

Internal DBR 230VAC		Recommended Heavy Duty DBR 230VAC	
Model Number	**DB Min Res Value**	**Model Number**	**DB Min Res Value**
RSi001SX2S_	250Ω	RSi001SX2S_	56Ω
RSi002SX2S_	125Ω	RSi002SX2S_	56Ω
RSi003SX2S_	125Ω	RSi003SX2S_	43Ω
RSi001SX2_	250Ω	RSi001SX2_	56Ω
RSi002SX2_	125Ω	RSi002SX2_	56Ω
RSi003SX2_	125Ω	RSi003SX2_	43Ω
RSi005SX2_	125Ω	RSi005SX2_	27Ω
RSi007SX2_	60Ω	RSi007SX2_	30Ω
RSi010SX2_	60Ω	RSi010SX2_	30Ω
RSi015SX2_	20Ω	RSi015SX2_	13Ω
RSi020SX2_	20Ω	RSi020SX2_	13Ω
RSi025SX2_	20Ω	RSi025SX2_	4.3Ω
RSi030SX2_	20Ω	RSi030SX2_	4.3Ω

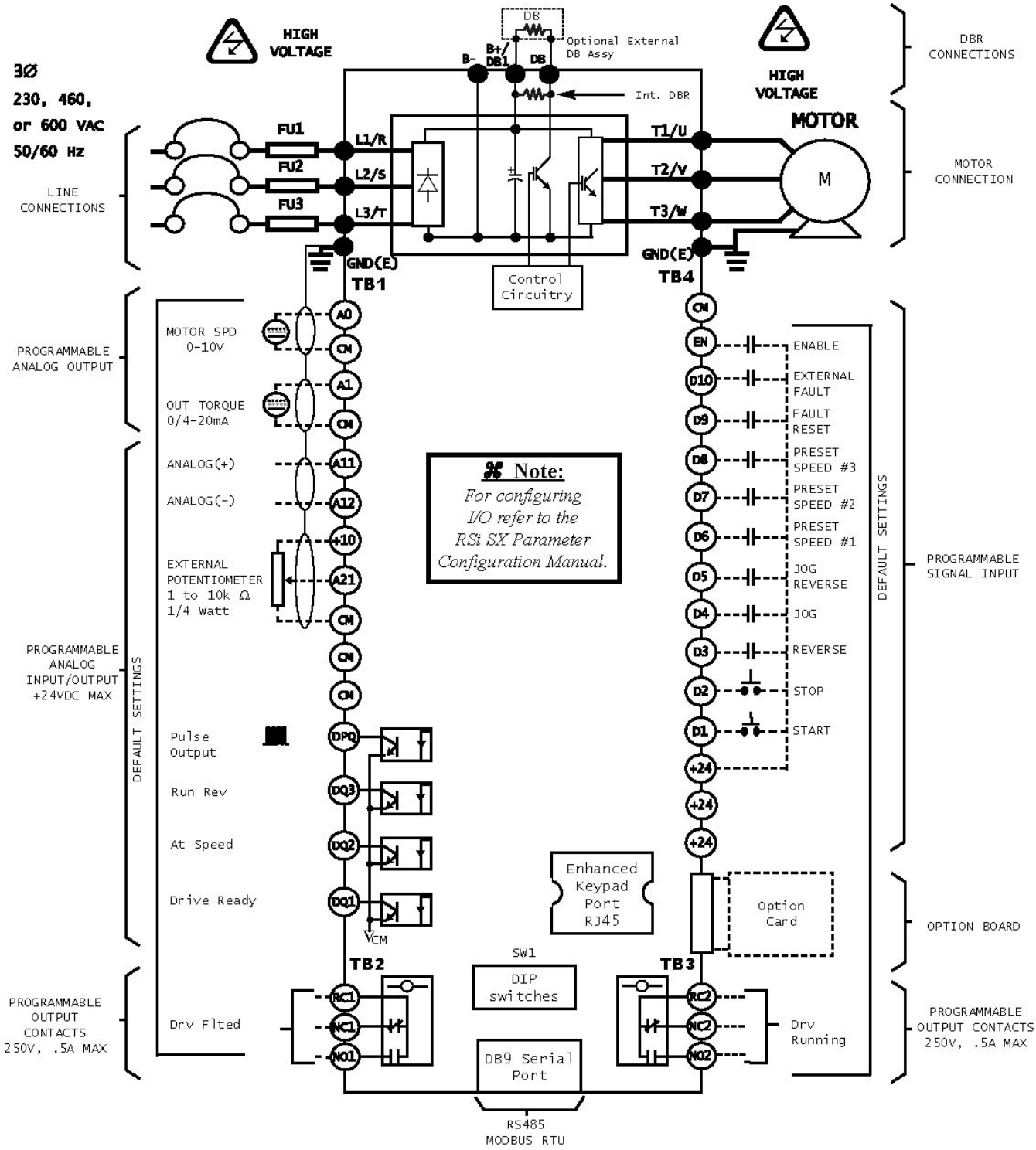
Table 24: Internal and Recommended DBR For 460VAC

Internal DBR 460VAC		Recommended Heavy Duty DBR 460VAC	
Model Number	**DB Min Res Value**	**Model Number**	**DB Min Res Value**
RSi001SX4_	1000Ω	RSi001SX4_	120Ω
RSi002SX4_	500Ω	RSi002SX4_	120Ω
RSi003SX4_	500Ω	RSi003SX4_	82Ω
RSi005SX4_	500Ω	RSi005SX4_	82Ω
RSi007SX4_	120Ω	RSi007SX4_	47Ω
RSi010SX4_	120Ω	RSi010SX4_	47Ω
RSi015SX4_	120Ω	RSi015SX4_	47Ω
RSi020SX4_	120Ω	RSi020SX4_	33Ω
RSi025SX4_	60Ω	RSi025SX4_	24Ω
RSi030SX4_	60Ω	RSi030SX4_	24Ω
RSi040SX4_	60Ω	RSi040SX4_	24Ω
RSi050SX4_	60Ω	RSi050SX4_	8.2Ω
RSi060SX4_	60Ω	RSi060SX4_	8.2Ω
RSi075SX4_	60Ω	RSi075SX4_	8.2Ω
RSi100SX4D	60Ω	RSi100SX4D	6Ω
RSi125SX4D	60Ω	RSi125SX4D	6Ω
RSi150SX4D	60Ω	RSi150SX4D	6Ω

Table 25: Internal and Recommended DBR For 600VAC

Internal DBR 600VAC		Recommended Heavy Duty DBR 600VAC	
Model Number	**DB Min Res Value**	**Model Number**	**DB Min Res Value**
RSi001SX6_	500Ω	RSi001SX6_	160Ω
RSi002SX6_	500Ω	RSi002SX6_	160Ω
RSi003SX6_	500Ω	RSi003SX6_	110Ω
RSi005SX6_	500Ω	RSi005SX6_	110Ω
RSi007SX6_	120Ω	RSi007SX6_	62Ω
RSi010SX6_	120Ω	RSi010SX6_	62Ω
RSi015SX6_	120Ω	RSi015SX6_	62Ω
RSi020SX6_	120Ω	RSi020SX6_	62Ω
RSi025SX6_	60Ω	RSi025SX6_	33Ω
RSi030SX6_	60Ω	RSi030SX6_	33Ω
RSi040SX6_	60Ω	RSi040SX6_	33Ω
RSi050SX6_	60Ω	RSi050SX6_	12Ω
RSi060SX6_	60Ω	RSi060SX6_	12Ω
RSi075SX6_	60Ω	RSi075SX6_	12Ω
RSi100SX6D	60Ω	RSi100SX6D	8.2Ω
RSi125SX6D	60Ω	RSi125SX6D	8.2Ω
RSi150SX6D	60Ω	RSi150SX6D	8.2Ω

BASIC WIRING



CONTROL TERMINALS

4.5 Terminals Found on the RSi SX Control Board

4.5.1 Description of the Control Terminals

Figure 7 shows the control terminals found on the TSP board of the RSi SX drive. (The actual control board cannot be accessed by the user.)

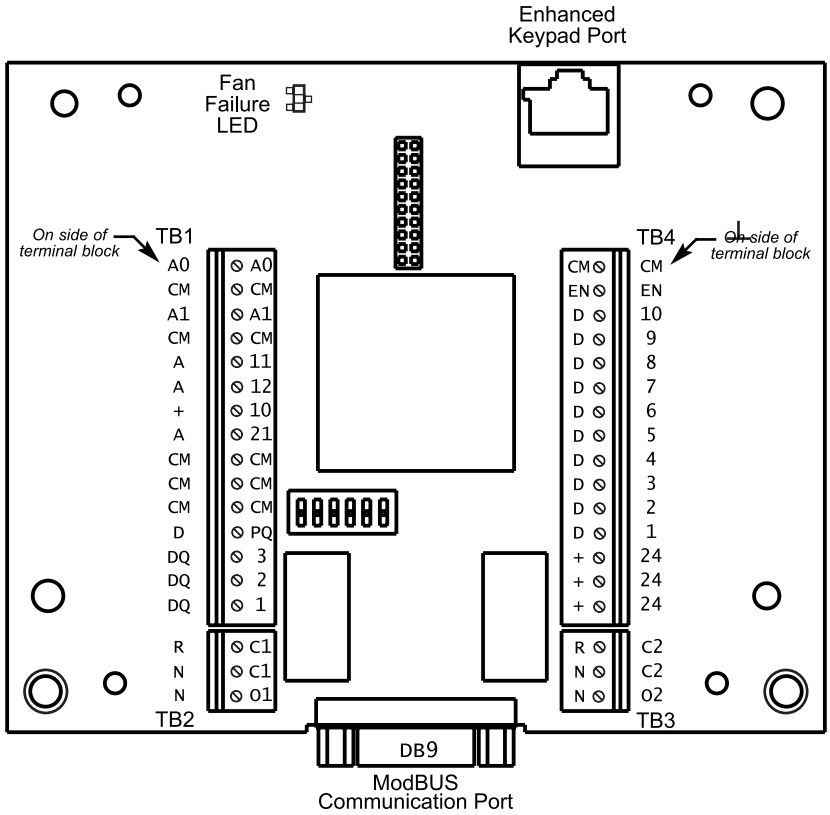
Note that due to labeling constraints, the labels for some terminals start on the left (either on the side or top of the terminal block), are interrupted by the terminal screw, and then finish on the right (either on the side or top of the terminal block). For example, terminal A11 is labeled with A on the left side of the block and 11 to the right of the terminal screw on top of the block. Similarly, terminal NC2 is labeled with N to the left of the terminal screw on top of the block and then C2 on the right side of the block.

As is shown in the figure, the terminals are divided into four terminal blocks, each of which pulls apart for ease of field wiring:

- TB1 – analog input, analog output, and digital output terminals.
- TB2 – output relay 1 (R1).
- TB3 – output relay 2 (R2).
- TB4 – digital input terminals.

See page 11 for specification information concerning these features. Table 26 starting on the next page describes the control terminals.

Figure 7: RSi SX Control Terminals



CONTROL TERMINAL DESCRIPTIONS

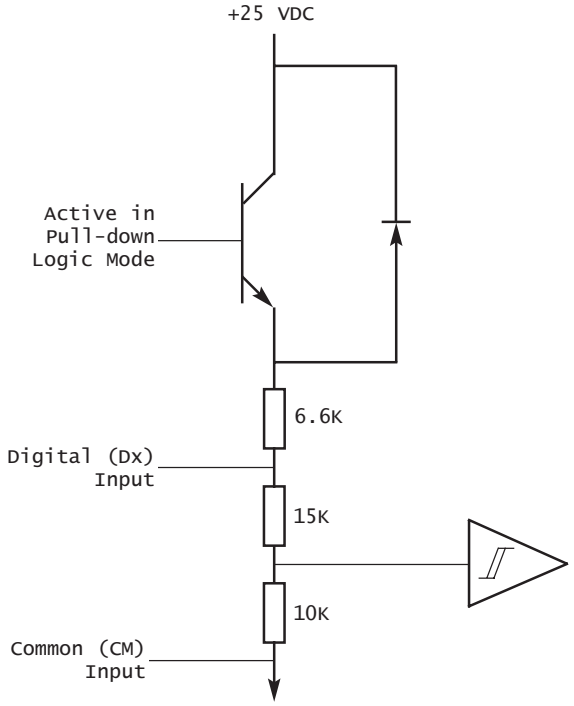
Table 26: Description of RSi SX Control Terminals

Terminal		Description
TB1 Terminal Block	A0	Analog output 1. This terminal may output 0 to 10VDC (5mA maximum). The type of signal output from this terminal is set with parameter I/O 37 (**A0 Configure**), with the default setting being Motor Spd (**motor speed**).
	A1	Analog output 2. This terminal outputs 0 to 20mA by default, but may be re-configured to 4 to 20mA by using parameter I/O 41 (**A1 Output Type**). The type of signal output from this terminal is set with parameter I/O 38 (**A1 Configure**), with the default setting being Out Torque.
	A11 A12	These two terminals comprise Analog Input 1, with A11 being the positive input and A12 being the negative input. The default setting for this input is 0 to 10VDC; this may be changed by re-configuring parameter I/O 26 (**A11 Configure**). The input signal may be 0 to 10VDC, 0 to 5VDC, ±10VDC, 0 to 20mA, or 4 to 20mA. These input signals provide speed references; DIP switch bank SW1 on the I/O board selects the type of input signal (see Table 24 on page 44 for information on setting the DIP switch). If a 0 to 20mA input signal is configured, the burden resistor may be set to either 50Ω or 250Ω via the DIP switch. The 50Ω setting is intended for current loop applications where multiple drives are chained together in series on one analog current reference. A potentiometer with a minimum value of 1kΩ may be used for this input.
	+10	This terminal is the reference supply for a potentiometer used in conjunction with A11 or A21. The supply voltage is +10VDC, with a maximum current capacity of 10mA.
	A21	This terminal is Analog Input 2. It is single-ended, and so the other lead from the circuit must be connected to a CM terminal. The input range is configured with parameter I/O 32 (**A21 Configure**), and may be an analog input or a pulse train up to 100kHz. The default setting for this input is 0 to 10VDC. This terminal may also be used to receive a Pulse Train Input. This signal may be an external pulse tach signal, or it may be the DPQ signal from another RSi SX drive. (A pull-up 4.7kΩ, 0.5Ω resistor may need to be connected between the A21 and +10 terminals for a signal from an RSi SX inverter; consult with Benshaw Inc. for further information.) The input signal may be 0 to 10VDC, 0 to 5VDC, or 0/4 to 20mA.The burden for this terminal can only be 250Ω. (See Table 24 on page 44 for more information.) A potentiometer with a minimum value of 1kΩ may be used for this input.
	DPQ	Open collector pulse train output. The output from this terminal is the drive's output frequency multiplied by 6 (default), 48, 96, or 3072 as set by parameter I/O 68 (**DPQ Scaling**, refer to PCM for more information). Output is 50% duty cycle, and may be used with voltages up to 24VDC.
	DQ1 to DQ3	Digital outputs 1 through 3. These are open collectors, external pull-up resistor may be required (min. 1kΩ). Each output is capable of sinking up to 90mADC. They require power to operate, either 24VDC from the drive or 10VDC to 35VDC from an external power supply. They are configured by parameters I/O 11 (**DQ1 Configure** - default setting is Drive Rdy), I/O 12 (**DQ2 Configure** - default setting is At Speed), and I/O 13 (**DQ3 Configure** - default setting is Run Rev); refer to PCM for more information.
TB2 Terminal Block	RC1	Common terminal for the first auxiliary relay. The function of the relay is set by parameter I/O 14 (**R1 Configure**). The default setting is for the relay to activate when a fault is detected (Drv Flted).
	NC1	Normally-closed contact for the first auxiliary relay. It will open when the relay is activated.
	NO1	Normally-open contact for the first auxiliary relay. It will close when the relay is activated.
TB3 Terminal Block	RC2	Common terminal for the second auxiliary relay. The function of the relay is set by parameter I/O 15 (**R2 Configure** - refer to PCM for more information). The default setting is for the relay to activate when the drive is running (Drv Run).
	NC2	Normally closed contact for the second auxiliary relay. It will open when the relay is activated.
	NO2	Normally-open contact for the second auxiliary relay. It will close when the relay is activated.
TB4 Terminal Block	EN	Enable terminal. A jumper is placed between this terminal and the +24 terminal at the factory. You may replace this with a contact if desired. The circuit from EN to +24 must be closed for the drive to operate. Note that unlike all other terminals, this terminal cannot be configured for "pull-down logic." that is, a high input to this terminal is always regarded as active — and must be present if the drive is to operate.
	D3 to D10	Digital inputs. The function of a digital input is configured by the parameter with the same name as the digital input in the DI Configure parameter group; (refer to PCM for more information).
	D2	Digital input. In 3-wire control, this must be a Stop input. In 2-wire control, it may be configured to another function with parameter I/O 02 (**D2 Configure**, refer to PCM for more information).
	D1	Digital input. This must be a Start or Run input.

4.5.2 Configuring the Type and Range of Analog Inputs

Either a 0 to 10VDC, 0 to 5VDC, or a 0/4 to 20mA input signal may be sent to Analog Input 1 and Analog Input 2. Only Analog Input 1 may accept a +/- 10VDC bipolar signal input. The selection of whether the input signal is voltage or current, as well as the voltage range and burden, is made via the DIP switch bank labeled SW1 located near terminal DQ3 (*see Figure 7 on page 37*).

Figure 8: Typical Digital Input Configuration



DIP SWITCH SETTINGS

Table 27: DIP Switch Settings PC655

Type of Input Signal and Range	SW1-1	SW1-2	SW1-3	SW1-4	SW1-5	SW1-6
Analog Input 1 (A11 + A12)						
0-10VDC[1]			Off	Off	Off	Off
0-5VDC[1]			On	Off	Off	Off
±10VDC[1]			Off	Off	Off	Off
0/4 to 20mA (50Ω)			Off	On	On	Off
0/4 to 20mA (250Ω)			On	Off	Off	On
Analog Input 2 (A21 & CM)						
0-10VDC[1]	Off	Off				
0-5VDC[1]	On	Off				
0/4 to 20mA (250Ω)	On	On				

1. The analog input impedance for voltage signals for PC655 input/output boards is 100kΩ.

CONTROL WIRING CONNECTIONS

4.5.3 Control Wiring Connections (Active-High Logic)

This section provides information on making typical control wiring connections when the digital inputs use Active-High logic ("pull-up logic"). This is the default type of logic used by the RSi SX drive.

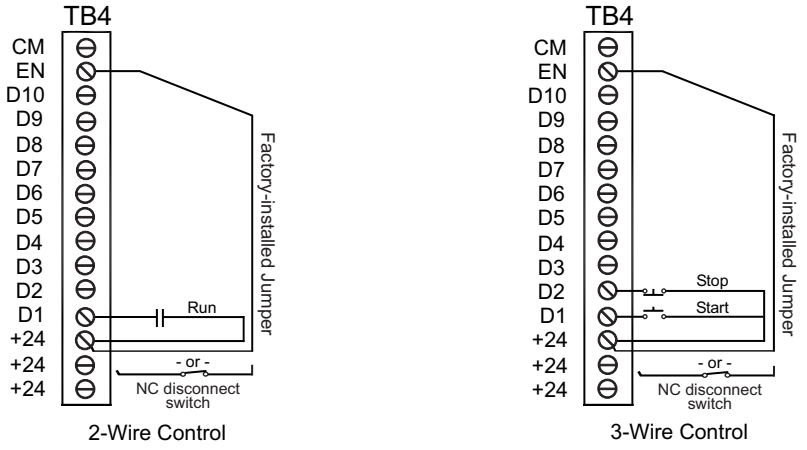
If desired, Active-Low logic may be utilized by setting parameter I/O 01 (Active Logic) to Active Low; refer to the RSi SX Parameter Configuration Manual for more information. Section 4.5.4 starting on page 49 provides connection drawings that utilize active-low logic.

Single-Direction Control
The RSi SX drive supports either 2- or 3-wire control. Figure 9 shows the connections to the digital input terminals for both types of control.

The default mode is 2-wire control. In this mode, digital input D1 is configured as the Run input and is not programmable, although additional Run inputs may be configured by using other digital inputs. An input on D1 will start the drive provided the Enable circuit is closed. (The Enable circuit is the connection between terminals EN and +24V, which may be either the factory-installed jumper or a normally-closed disconnect switch supplied by the customer.)

Also note that line-start lockout is enabled by default. With this feature, the drive will not start if a Run command is active when power is applied. To disable line-start lockout, configure parameter FUN 10 (Start Mode) to Auto Start; *refer to the RSi SX Parameter Configuration Manual for more information*.

Figure 9: 2- and 3-Wire Control (Active-High Logic)



Setting parameter FUN 05 (2-wire/3-wire S-S) to 3-wire selects 3-wire control, *refer to the Parameter Configuration Manual* . In this type of control, the drive is started based on the rising edge of a pulse on a Start digital input. In addition the Enable circuit must be closed for the drive to be started.

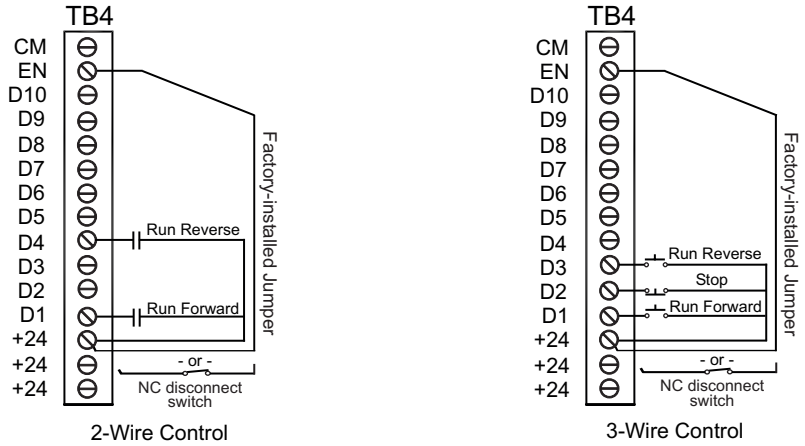
The drive is stopped on the falling edge of a pulse on a Stop digital input.

Forward and Reverse Control
An additional digital input may be added to the basic, single-direction 2-wire and 3-wire control discussed in the previous section to allow control in two directions. The RSi SX drive supports two types of terminal-strip directional control: Terminal-1 and Terminal-2. In addition, either forward or reverse direction can be disabled through parameter AFN 17 (Run Prevent).

Terminal-1 direction control:
When FUN 04 (Run/Stop Set) is set to Terminal-1, any active Forward input will command the drive to start the motor in the forward direction, and any active Reverse input will command the drive to rotate the motor in the reverse direction. If both Forward and Reverse inputs are active, priority is given to the Forward direction.

Terminal-2 direction control:
When FUN 04 (Run/Stop Set) is set to Terminal-2, the Forward inputs command a drive Run signal, and the Reverse inputs set the direction of rotation. If reverse inputs are not active, the drive commands the Forward direction.

Figure 10: Example of Run Forward/Run Reverse Control (Active-High)



⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

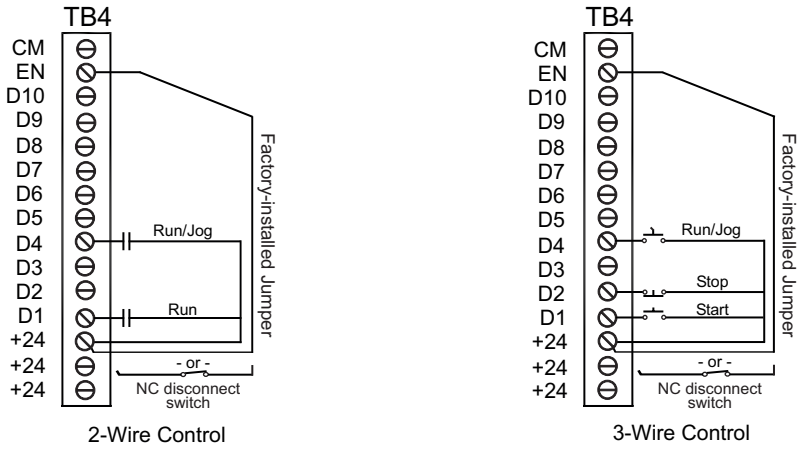
Jogging Operation
The RSi SX drive supports Jog operations for both 2- and 3-wire control. Two jogging modes are available: Run/Jog DI or Pushbutton Jog, with parameter FUN 11 (Jog Mode) selecting which is used. (*Refer to the RSi SX Parameter Configuration Manual for information on this parameter*.)

Jogging operations are controlled by a digital input (D2 to D10 for 2-wire control or D4 to D10 for 3-wire control, with D4 being the default choice). The selected digital input also needs to be configured for the type of jogging (*see the DI Configure parameter group in Programming Manual for more information*).

In the Run/Jog DI mode, a maintained-contact digital input is required. Figure 11 shows an example of the connections for this mode with digital input D4 assigned to jogging.

In this example for 2-wire control, if the drive is running, activating D4 will cause the drive to ramp from the normal reference to the Jog reference using the appropriate acceleration or deceleration Jog ramp. When D4 is deactivated, the drive will ramp back to the normal reference using the appropriate acceleration or deceleration Jog ramp.

Figure 11: Example of Connections for the Run/Jog Mode (Active-High Logic)



⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

If the drive is stopped rather than running, activating D4 and then activating the Run digital input (D1) will cause the drive to start and ramp to the Jog reference using the Jog acceleration ramp. When D1 is deactivated (and D4 is still activated), the drive will ramp to stop using the Jog deceleration ramp.

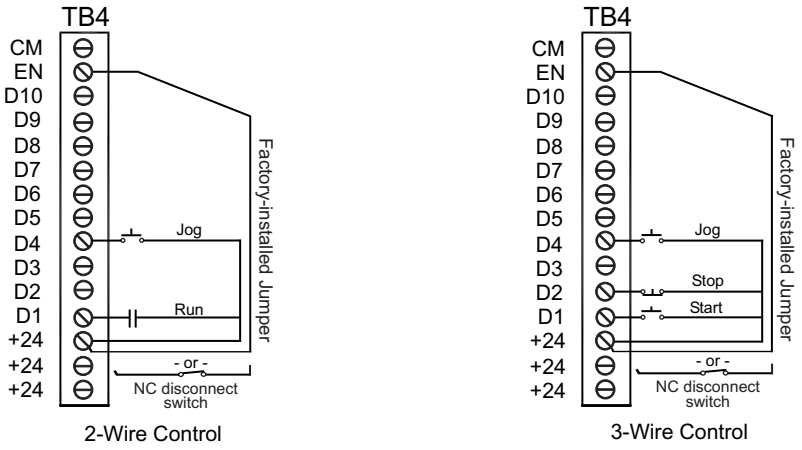
In this example for 3-wire control, when D4 is active, jogging operations may occur. The jog speed and ramp are enabled as set by the appropriate parameters. While D4 is active, pressing the Start pushbutton causes a ramp to the jogging reference speed and releasing the Start pushbutton causes the speed to go to zero using the jog ramp.

Note that if the jog input is opened (returned to Run) while Start is pressed, the drive will ramp back to the normal reference speed without first stopping.

In the second type of jogging (Pushbutton Jog), a pushbutton is incorporated into the control scheme to initiate jogging. Figure 11 on page 43 shows an example of this type of jogging. In this example, in both 2- and 3-wire control, if the drive is already running, pressing the jog pushbutton will have no effect. When the drive is stopped and the input to D4 is activated by pressing the pushbutton, the drive will ramp to the jogging reference speed by parameter FUN 08 (Jog Ref Config; *refer to the Parameter Configuration Manual*) in the time set by parameter FUN 12 (Jog Accel Time). When the input is deactivated, the drive speed goes to zero in the time set by parameter FUN 13 (Jog Decel Time).

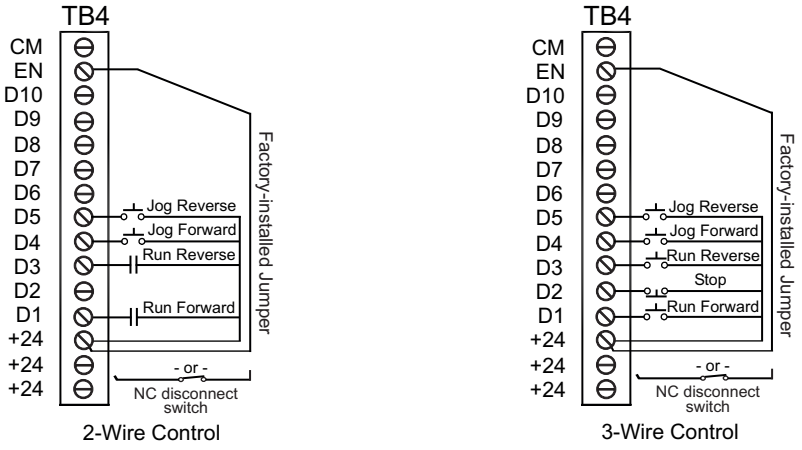
Note that these examples showed 2- and 3-wire control systems running in one direction. Jogging may also be incorporated into control systems that run in two directions. For these applications, two digital inputs are required - one for Forward Jog and one for Reverse Jog with the particular type of jogging selected by parameter configuration (Run/Jog DI or Pushbutton Jog) controlling the jog operations. Figure 13 on page 45 shows examples of Forwards and Reverse jogging operations.

Figure 12: Example of Connections for the Pushbutton Jog Mode, Forward Operation Only (Active-High Logic)



⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

Figure 13: Example of Connections for Forward and Reverse Jogging (Active-High)



⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

Preset Speeds
The RSi SX drive supports up to seven preset speeds, which are in addition to the reference speed of the drive. The preset speeds may be selected by using digital inputs or serial communication to set bits 5, 6, and 7 of Cntl Word 1 (*see RSi SX Parameter Configuration Manual for information on this parameter*). Figure 14 shows an example of connections for seven preset speeds using three digital inputs.

If digital inputs are used, the number of preset speeds available is determined by the number of digital inputs assigned this functionality:
- If three digital inputs are used, all seven preset speeds are available.
- If two digital inputs are used, only Preset Speed 1, Preset Speed 2, and Preset Speed 3 are available.
- If only one digital input is used, only Preset Speed 1 is available.

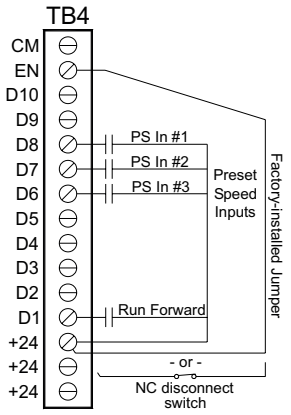
(See parameters I/O 02 (D2 Configure) through I/O 10 (D10 Configure) in Programming Manual for more information on assigning digital inputs to selection of preset speeds.)

The preset speeds are configured by parameters I/O 20 (Preset Speed 1) to I/O 26 (Preset Speed 7) found in the Prest Speeds parameter group (*refer to the Parameter Configuration Manual for more information on the preset speed parameters*).

A particular speed is selected by the combination of inputs on the terminals assigned to the preset speeds. Table 28 on page 47 show what speeds are selected by an input combination depending on the number of digital inputs used.

⌘ **NOTE:** Preset Speeds are not available when the reference is the keypad (see FUN 06 - Reference Source).

Figure 14: Example of Connections for Seven Preset Speeds (Active-High Logic)



⌘ **Note:** Inputs D3 to D10 are programmable; refer to the PCM for configuration information.

For commanding preset speeds via serial communication, the speeds are selected much as when three digital inputs are configured. A combination of on and off states (1s and 0s) of bits 5, 6, and 7 of Cntl Word 1 determine the active preset speed. Table 29 on page 48 shows how the settings of the bits combine to select an active preset speed.

Note that if fewer than seven preset speeds are desired, you do not need to set all three preset speed bits. By leaving one (or two) of the bits in its default state of 0, and only varying the value of the other two (or one) bits, fewer preset speeds could be commanded.

For example, Table 29 on page 48 shows that if bit 7 remained at 0 while serial communications changed the values of the other two bits, only preset speeds 1 through 3 (plus the reference speed) would be available.

Table 28: Selection of Preset Speed

One Digital Input	
Digital Input Configured as "PS In #1"	**Speed Selected**
0	Reference Speed
1	Preset Speed 1

Two Digital Input		
Digital Input Configured as "PS In #2"	**Digital Input Configured as "PS In #1"**	**Speed Selected**
0	0	Reference Speed
0	1	Preset Speed 1
1	0	Preset Speed 2
1	1	Preset Speed 3

Three Digital Input		
Digital Input Configured as "PS In #2"	**Digital Input Configured as "PS In #1"**	**Speed Selected**
0	0	Reference Speed
0	0	Preset Speed 1
0	1	Preset Speed 2
0	1	Preset Speed 3
1	0	Preset Speed 4
1	0	Preset Speed 5
1	1	Preset Speed 6
1	1	Preset Speed 7

Table 29: Selection of Preset Speeds Using Serial Communication

State of Bit 7 of Cntl Word #1	State of Bit 6 of Cntl Word #1	State of Bit 5 of Cntl Word #1	Speed Selected
0	0	0	Reference Speed
0	0	1	Preset Speed 1
0	1	0	Preset Speed 2
0	1	1	Preset Speed 3
1	0	0	Preset Speed 4
1	0	1	Preset Speed 5
1	1	0	Preset Speed 6
1	1	1	Preset Speed 7

DC Injection Braking by DI

The RSi SX drive supports DC injection braking to assist in stopping high-inertia loads. A digital input (D2 to D10 for 2-wire control or D3 to D10 for 3-wire control; *refer to the RSi SX Parameter Configuration Manual*) may be selected as the input to activate DC injection braking, and the parameter that controls the functionality of the selected input is set for DC injection braking.

When controlled by a digital input, DC injection braking is not a timed function. As long as the selected digital input is active, direct current will be injected into the motor.

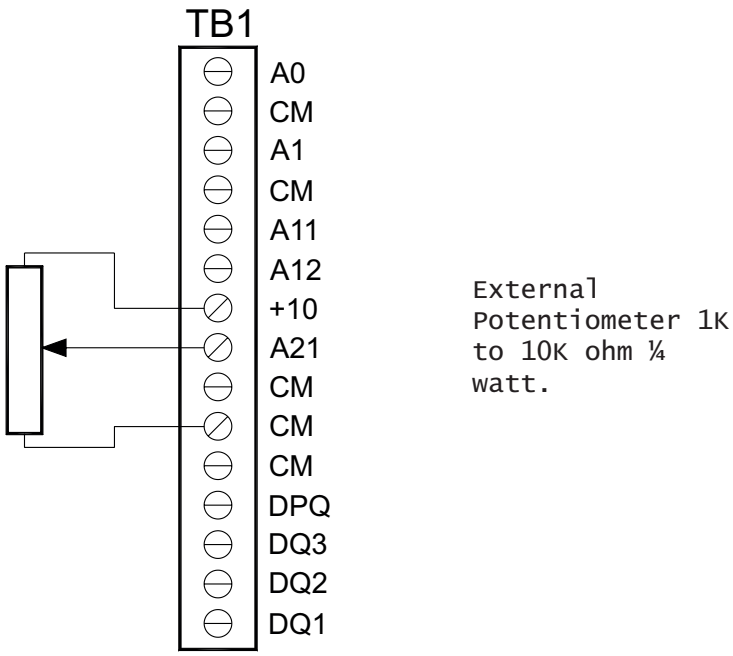
⌘ **NOTE:** DC Injection brake effectiveness drops off rapidly once the motor is over 50% of its nominal speed. Very little braking torque will be experienced even though the motor will be heating significantly.

CAUTION

Extended use of DC Injection can reduce the life of the motor.

Speed Potentiometer
A speed potentiometer may be connected to analog input 2 (the A21 terminal), as shown in Figure 15. (Analog input 1, the A11 and A12 terminals, may also be configured to accept a speed potentiometer input.)

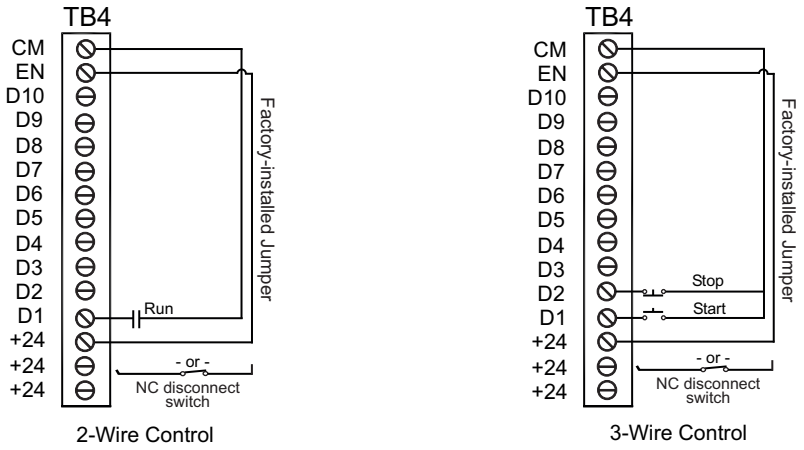
Figure 15: Connections for a Typical Speed Potentiometer



4.5.4 Control Wiring Connections (Active-Low Logic)

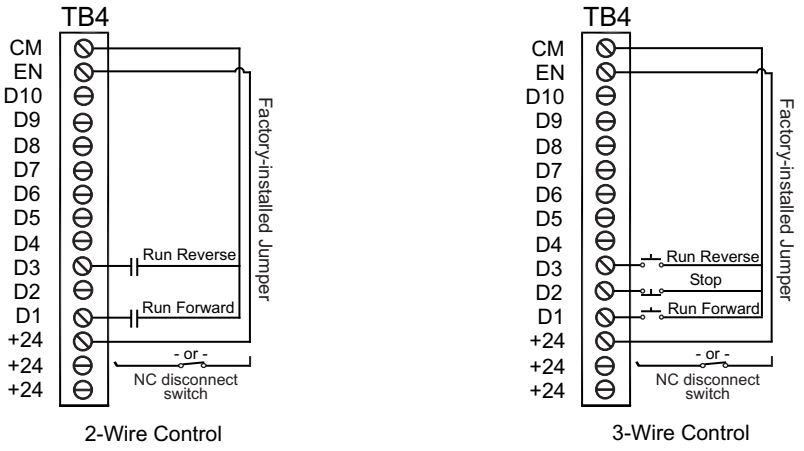
The previous section described typical wiring connections when Active-High logic is used for the digital inputs. This section provides, starting on the next page, the typical control wiring connections when the digital inputs use Active-Low logic ("pull-down logic"). (Active-Low logic is selected by setting parameter I/O 01 (Active Logic) to Active Low; *see the RSi SX Parameter Configuration Manual for more information*.) Note that this section only provides the connection diagrams; for a discussion of the function diagrammed, see the previous section.

Figure 16: Connections for 2- and 3-Wire Control (Active-Low Logic)



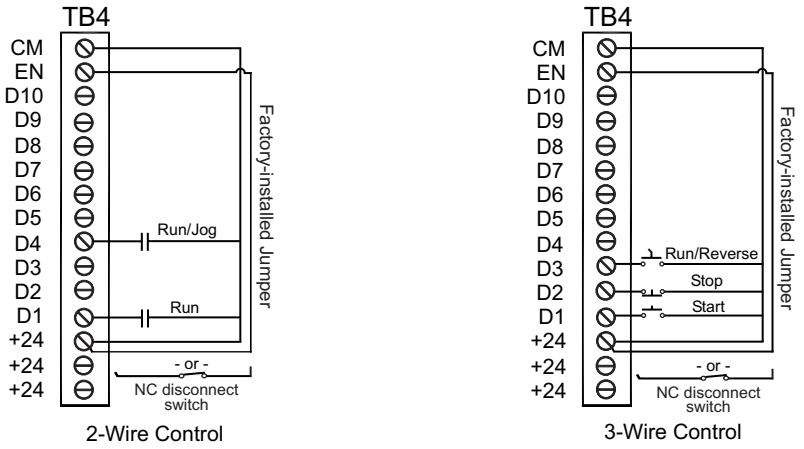
⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

Figure 17: Example of Run Forward/Run Reverse Control (Active-Low Logic)



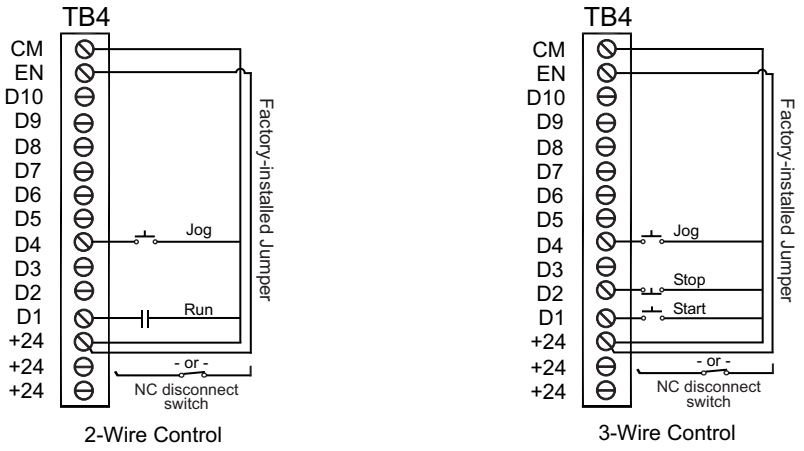
⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

Figure 18: Example of Connections for Run/Jog DI Mode (Active-Low Logic)



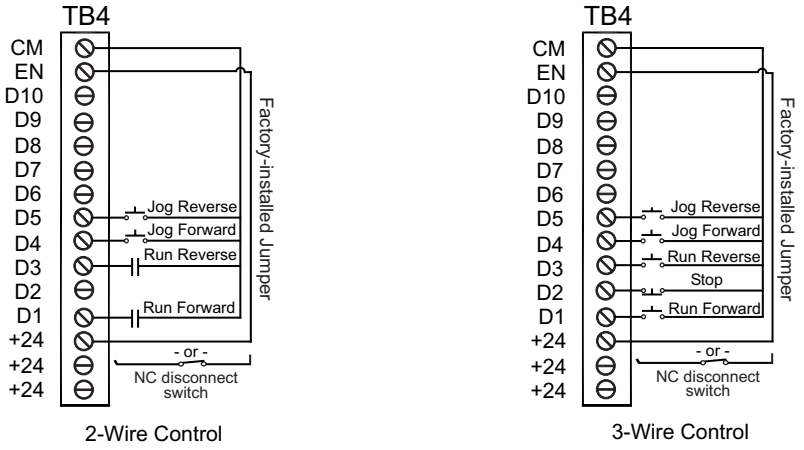
⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

Figure 19: Example of Connections for the Pushbutton Jog Mode, Forward Operation Only (Active-Low Logic)



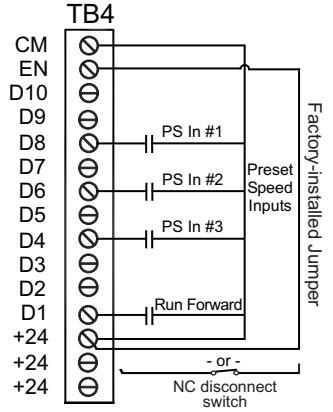
⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

Figure 20: Example of Connections for the Forward and Reverse Jogging (Active-Low)



⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

Figure 21: Example of Connections for Seven Preset Speeds (Active-Low Logic)



⌘ **Note:** *Inputs D3 to D10 are programmable; refer to the PCM for configuration information.*

5 Troubleshooting & Maintenance

5.1 Fault Remedy

Table 30

Protective Function	Cause	Remedy
Over Current Protection	1) Acceleration/Deceleration time is too short compared to the inertia of the load. 2) Inverter turns output on when the motor is still rotating. 3) Output short or ground fault has occurred. 4) Mechanical brake of the motor is operating too fast. 5) Components of the main circuit have overheated due to a faulty cooling fan or blocked cooling.	1) Increase Accel/Decel time. 2) Operate after motor has completely stopped. 3) Check output wiring. 4) Check mechanical brake operation. 5) Check cooling fan. **(CAUTION)** Operating VFD prior to correcting fault may damage the IGBTs.
Ground Fault Protection	1) Ground fault has occurred at the output wiring of VFD. 2) The insulation of the motor has been damaged.	1) Investigate the output wiring of VFD. 2) Exchange motor.
Over Voltage Protection	1) Deceleration time is too short compared to the inertia of load. 2) Regenerative load at the output. 3) Line voltage high.	1) Increase deceleration time 2) Install Dynamic braking / resistor option 3) Check line voltage
Current Limit Protection (Overload Protection)	1) Load is larger than the VFD rating. 2) Selected incorrect VFD capacity parameter. 3) Selected incorrect V/F pattern.	1) Increase capacity of motor anrrect VFD capacity. 2) Select correct V/F pattern.
Heat Sink Overheat	1) Cooling fan damaged or a foreign substance is blocking fan. 2) Cooling system has faults. 3) Ambient temperature too high.	1) Exchange cooling fans and/or eliminate foreign substance. 2) Check for foreign substances in the heat sink. 3) Keep ambient temperature under°C.
Electronic Thermal	1) Motor has overheated. 2) Load is larger than VFD rating. 3) ETH level set too low. 4) Set incorrect V/F pattern. 5) Motor operated too long at low speeds.	1) Reduce load and/or running duty. 2) Increase VFD capacity. 3) Adjust ETH level to an appropriate level. 4) Select correct V/F pattern. 5) Install a cooling fan with a separate power supply.
External Fault	External Fault has occurred.	Eliminate fault art circuit connected to external fault termnal or cause of external fault input.
Low Voltage Protection	1) Line voltage low. 2) Load larger than line capacity is connected to line (welding machine, motor with high starting current connected to the commercial line).	1) Check line voltage. 2) Increase line capcity.
IGBT Short	1) Short has occurred between the upper and lower IGBT. 2) Short has occurred at the output of the VFD. 3) Acceleration/Deceleration time is too short compared to the inertia of the load.	1) Check IGBT. 2) Check output wiring of VFD. 3) Increase acceleration or deceleration time.
Inverter Overload	1) Load is larger than VFD rating. 2) Selected incorrect VFD capacity.	1) Increase motor and/or VFD capacity. 2) Select correct VFD capacity.
Magnetic	1) The magnetic contactor malfunction.	1) Replace the magnetic contactor.
Contactor Fail	1) The Control Power Transformer (CPT) fuse has opened.	1) Replace the CPT fuse.

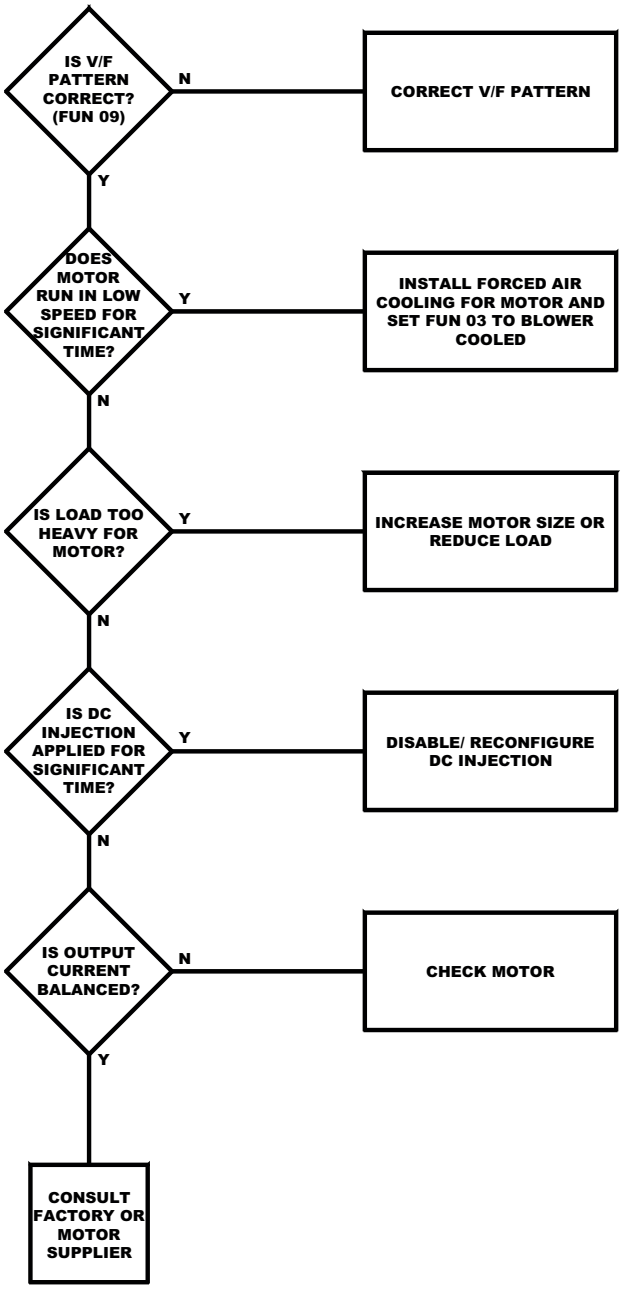
5.2 Troubleshooting

Table 31

Condition	Check Point
The Motor Does Not Rotate	1) Main circuit inspection: • Is the input (line) voltage normal? (Is the LED in the VFD lit)? • Is the motor connected correctly? 2) Input signal inspection: • Check the operating signal input to the VFD. • Check the forward and the reverse signal input simultaneously to the VFD. • Check the command frequency signal input to the VFD. 3) Parameter setting inspection: • Is the Run Prevention AFN 17 function set? • Is the Start/Stop Config (FUN 04) set correctly? • Is the drive enable (EN) terminal input active? • Is the command frequency set to 0? 4) Load inspection: • Is the load too large or is the motor jammed? • Is a mechanical or supplemental brake engaged? 5) Other: • Is the alarm displayed on the keypad or is the Stop LED blinking?
The Motor Rotates in Opposite Directions	Is the phase sequence of the output terminal T1/U, T2/V, T3/W correct? Is the starting signal (forward/reverse) connected correctly?
The Difference Between the Rotating Speed and the Reference is Too Large	Is the frequency reference signal correct? (Check the level of the input signal) Are the following parameter settings correct? Minimum Frequency (AFN 04), Maximum Frequency (AFN 03), Analog Input Configuration (I/O 27-36) Is the input signal line influenced by external noise? *(Use a shielded wire)*. Are there skip frequencies programmed?
The VFD Does Not Accelerate or Decelerate Smoothly	Is the acceleration/deceleration time is set too short a period of time? Is the load too large? Is the Torque Boost Configuration (AFN 07-11) set incorrectly?
The Motor Current is Too High	Is the load too large? Is the Torque Boost Value (see above) too high?
The Rotating Speed Does Not Increase	Is the Maximum Frequency (AFN 03) value correct? Is the load too large?
The Rotating Speed Oscillates When the VFD is Operating.	1) Load inspection: • Is the load oscillating? 2) Input signal inspection: • Is the frequency reference signal oscillating?

5.2.1 Motor Overheats

Figure 22

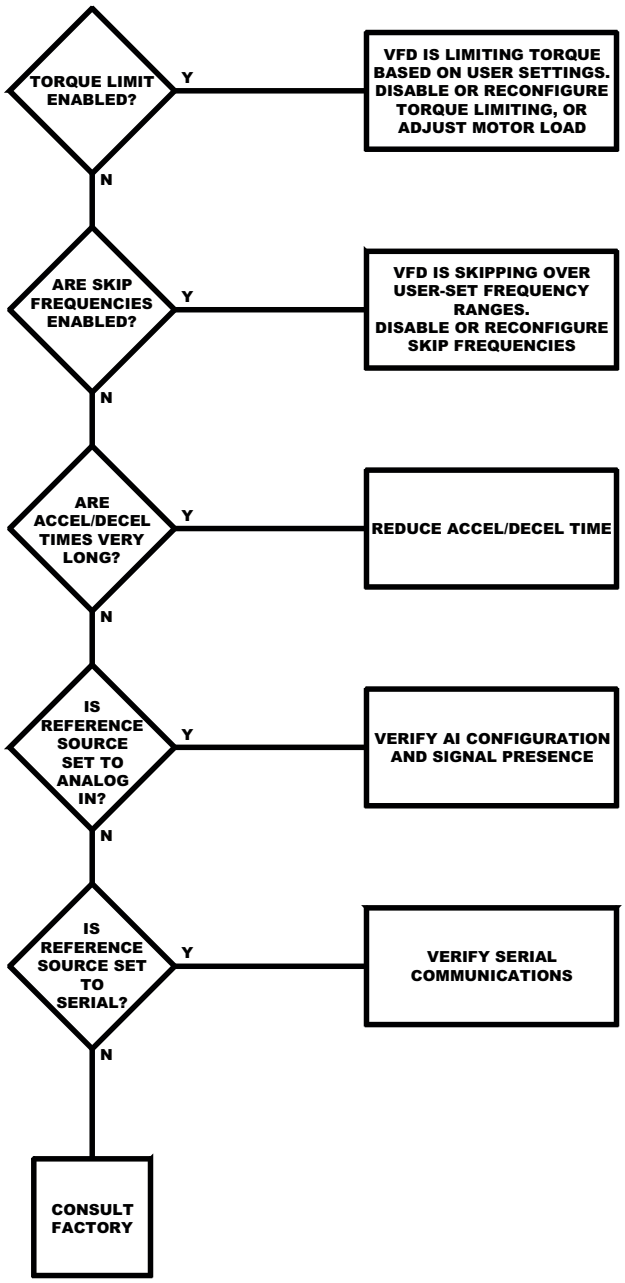


DANGER

Risk of Electric Shock - Ensure all electrical power is removed before servicing.

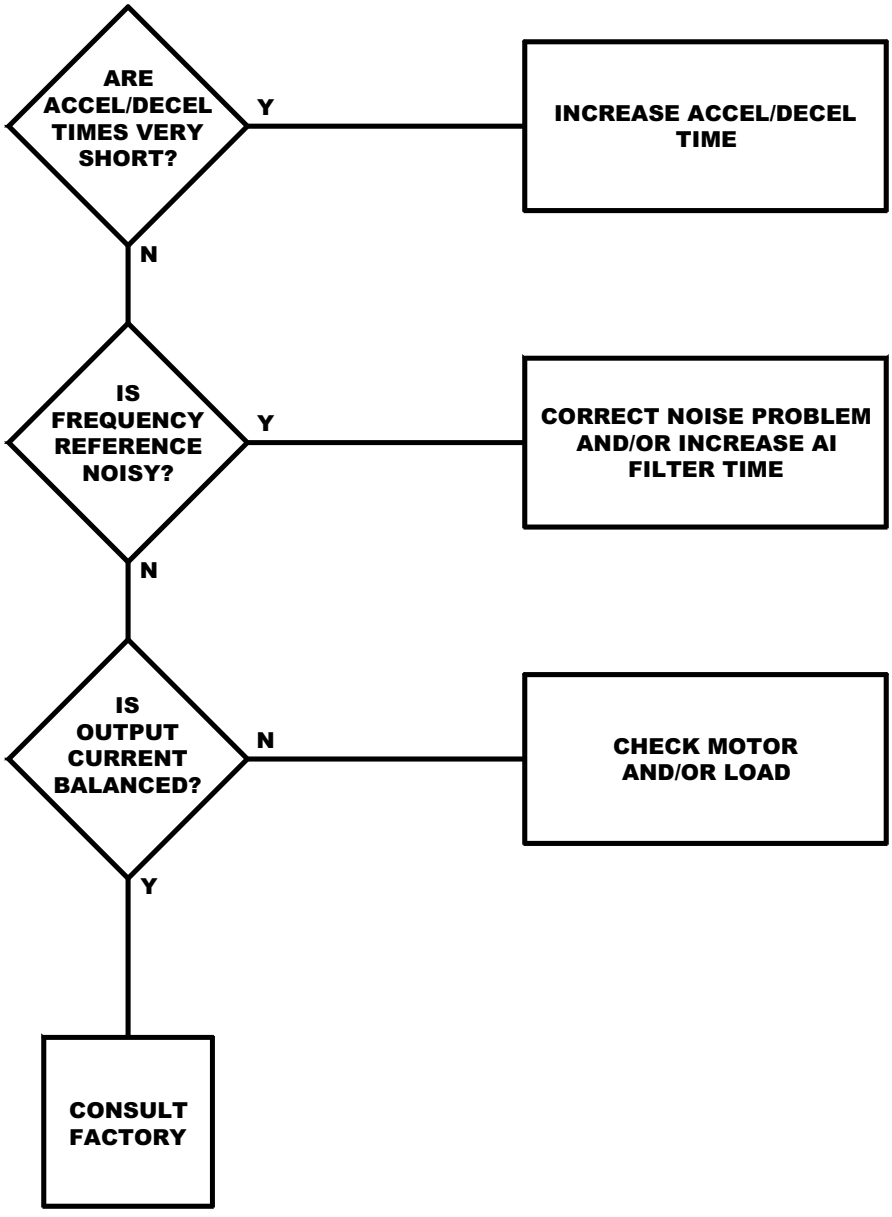
5.2.2 Motor Speed is not equal to the Command Frequency

Figure 23



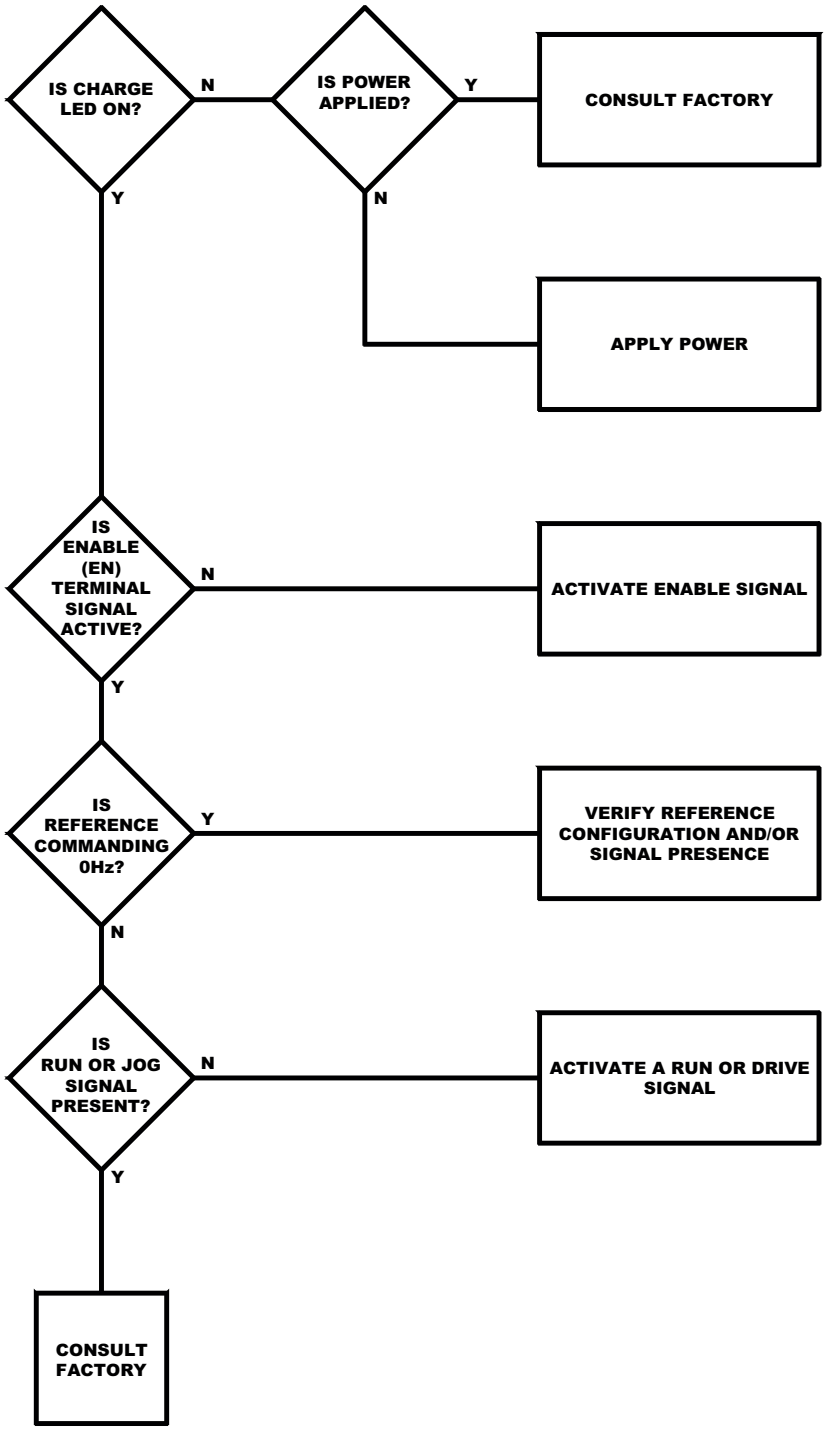
5.2.3 Motor does not run Smoothly

Figure 24



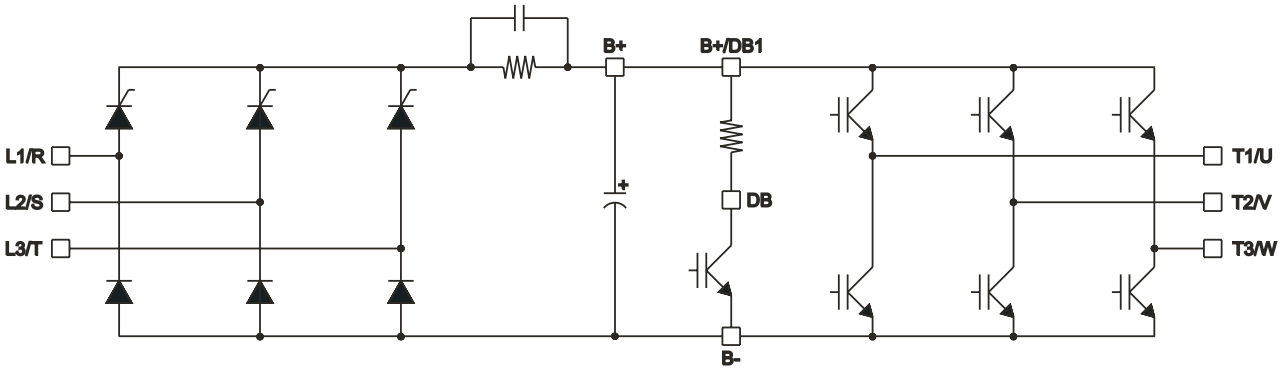
5.2.4 Motor Does Not Run

Figure 25



5.3 How to Check Power Components

Figure 26



- Diode Module Check

Check Module	Resistance to be Good
R,S,T - B+	50K ohms or more
R,S,T - B-	50K ohms or more

- DB (Dynamic Braking) IGBT

Check Module	Resistance to be Good
DB - B+/DB1	See PCM
DB - B-	50K ohms or more

- IGBT Module check

Check Module	Resistance to be Good
U, V, W - B+	50K ohms or more
U, V, W - B-	50K ohms or more

⌘ **NOTE:** If the drive has been powered-off for more than two years, it is strongly recommended that the drive be sent back to the factory to recondition the electrolytic capacitors.

MAINTENANCE

5.4 Maintenance

The RSi SX Series can be influenced by temperature, humidity, and vibration. To avoid any possible uncertainty, the drive must be maintained properly by certified personnel.

PRECAUTIONS

5.5 Precautions

- Be sure to remove the drive power input while performing maintenance.
- Be sure to perform maintenance only after checking that the bus has discharged.
- The bus capacitors in the electronic circuit can still be charged even after the power is turned off.
- The correct output voltage can only be measured by using a rectifier voltage meter. Other voltage meters, including digital voltage meters, are likely to display incorrect values caused by the high frequency PWM output voltage of the drive.

ROUTINE INSPECTION

5.6 Routine Inspection

Be sure to check the following before operation:

- The conditions of the installation location
- The conditions of the drive cooling
- Abnormal vibration
- Abnormal heating

PERIODICAL INSPECTION

5.7 Periodical Inspection

- Are there any loose bolts, nuts or rust caused by surrounding conditions? If so, tighten up or replace them.
- Are there any deposits inside the drive-cooling fan? If so, remove using compressed air.
- Are there any deposits on the drive's PCB (Printed Circuit Boards)? If so, remove using filtered and dried compressed air.
- Are there any abnormalities in the various connectors of the drive's PCB? If so, check the condition of the connector in question.
- Check the rotating condition of the cooling fan, the size and condition of the capacitors and the connections with any magnetic contactors. Replace them if there are any abnormalities.

5.8 Daily and Periodic Inspection Items

Table 32

Inspection Location	Inspection Item	Inspection	Period			Inspection Method	Criterion	Measuring Instrument
			Daily	1 Year	2 Year			
All	Ambient Environment	Is there any dust? Is the ambient temperature and humidity adequate?	O			Refer to the precautions	Temperature: -10~+40 no freezing. Humidity: Under 90% no dew	Thermometer, Hygrometer, Recorder
	Equipment	Is there any abnormal oscillation or noise?	O			Use sight and hearing	No abnormality	
	Input Voltage	Is the input voltage of the main circuit normal?	O			Measure the voltage between the terminals L1/R, L2/S, L3/T		Digital Multi-Meter / Tester
Main Circuit	All	Megger check (between the main circuit and the ground) Are any fixed parts removed? Are there any traces of overheating at each component's cleaning?		O O O		None. Consult Factory. Tighten the screws. Visual check.	No fault	
	Conductor / Wire	Is the conductor oxidized? Is the wire coating damaged?		O		Visual check	No fault	
	Terminal	Is there any damage?		O		Visual check	No fault	
	IGBT Module/ Diode Module	Check the resistance between each of the terminals.			O	Undo the VFD connection and measure the resistance between R,S,T and U,V,W with a tester.	(Refer 'How to Check Power Components")	Digital Multi-Meter / Analog Tester
	Smoothing Capacitor	Is there any liquid coming out? Is the safety pin out, and is there any swelling? Measure the capacitance.	O O	O		Visual check. Measure with a capacitance- measuring device.	No fault Over 85% of the rated capacity	Capacitance Measuring Device
	Relay	Is there any chattering noise during operation? Is there any damage to the contact		O O		Auditory check. Visual check	No fault	
	Resistor	Is there any damage to the resistor insulation? Is the wiring in the resistor damaged (open)?		O O		Visual check. Disconnect one of the connections and measure with a tester.	No fault Error must be within ±10% the displayed resistance	Digital MultiMeter / Analog Tester
Control Circuit Protective Circuit	Operation Check	Is there any unbalance between each phases of the output voltage? Nothing must be wrong with display circuit after executing the sequence protective operation		O O		Measure the voltage between the output terminals U, V and W. Short and open the VFD protective circuit output.	The voltage balance between the phases for 200V (800V) class is under 4V (8V).The fault circuit operates according to the sequence.	Digital Multi-Meter/Rectifying Voltmeter
Cooling System	Cooling Fan	Is there any abnormal oscillation or noise? Is the connection area loose?	O	O		Turn OFF the power and turn the fan by hand. Tighten the connections.	Must rotate smoothly. No fault	
Display	Meter	Is the displayed value correct?	O	O		Check the meter reading at the exterior of the panel	Check the specified and management values.	Voltmeter / Ammeter etc.
Motor	All	Are there any abnormal vibrations or noise? Is there any unusual odor?	O O			Auditory, sensory, visual check. Check for overheat and damage.	No fault	
	Insulation Resistor	Megger check (between the output terminals and the ground terminal)			O	Disconnect motor from VFD and short motor leads together.	Over 5MO	500V class Megger

5.9 Functions Based on Use

Set the function properly according to the load and operating conditions. Applications and related functions are listed in the following table.

Table 33

Use	Related Parameter Code
Accel/Decel Time, Pattern Adjustment	DRV 02 [Acceleration Time], DRV 03 [Deceleration Time], FUN 32 [Acceleration Shape], FUN 34 [Deceleration Shape]
Reverse Rotation Prevention	AFN 17 [Run Prevent]
Minimum Accel/Decel Time	DRV 02 [Acceleration Time], DRV 03 [Deceleration Time]
Braking Operation Adjustment	FUN 36 [Stop Mode], FUN 18-22 [DC Braking],
Operations for Frequencies Over 60Hz	AFN 01 (Nominal Motor Frequency), AFN 02 (Nominal Motor RPM) AFN 03 (Maximum Frequency)
Selecting Appropriate Output Characteristics for the Load	AFN 03 [Maximum Frequency], AFN 05 [Nominal Motor Frequency]
Motor Output Torque Adjustment	AFN 04 (minimum frequency), FUN 09 (torque type) FUN 24-31 (torque configuartion), AFN 08-11 (Voltage Boost)
Output Frequency Limit	AFN 03-04 (Max/Min Frequency) Analog Input configuration (See I/O 27-36)
Motor Overheat Protection	FUN 03 (Motor Type), AFN 22-23 (Overload Characteristics)
Multiple Preset Frequencies	I/O 02-10 (DI Configure) I/O 20-26 (Preset Speed Configure)
Jog Operation	FUN 08 (Jog Reference), FUN 11-13 (Jog configuration)
Frequency Skip Operation	FUN 37-47 (Skip Frequency Configuration)
Timing the Electronic Brake Operation	FUN 18-22 (DC Brake Configure)
Displaying the Rotating Speed	FUN 61-66 (Display Configuration)
Function Alteration Prevention	FUN 67-69 (Security Configure)
Auto Restart after Fault	FUN 10 (Start Mode), AFN 54-57 (Fault Reset Configuration)
PID Feedback Operation	AFN 60-77 (PID Configuration)
Frequency Reference Configuration	FUN 06 (Frequency Setting), FUN 07 (Main Speed Reference) I/O 27-36 (Analog Input Configuration),
Define the Multi-Function Input Terminals	I/O 01-10 (DI Configuration)
Metering	I/O 37-41 (Analog Out Configuration)
Remote Control/Communications	AFN 24-28 (Communications Configuration)
Operation on Single Phase	AFN 53 (Input Phase Fault)

5.10 Parameters Based on Application

Table 34

Application	Param. #
When you want to change the frequency setting	Press Enter at the Operate Screen
When you want to change the acceleration and deceleration time of the motor	DRV 01, DRV 02
When you want to change the run/stop method	FUN 04
When you want to change the frequency reference source	FUN 06
When you want to prevent the motor from rotating in opposite directions	AFN 17
When you want to change the stopping method	FUN 36
When DC injection braking is required before starting	AFN 12-13
When you want to set the maximum frequency and the base frequency according to the rated torque of the motor	AFN 01-02
When you want to adjust the starting frequency	AFN 04
When a large starting torque is needed for loads such as elevators (Manual/Auto Torque Boost)	AFN 08-11
When you want to select an appropriate output characteristic (V/F characteristic) according to loads	FUN 09
When you want to set up your own V/F pattern	AFN 08-11
When you want to protect the motor from overheating	FUN 03, AFN 22-23
When you want to output a signal when the overload condition lasts more than a fixed amount of time	FUN 50-51
When you want to prevent the resonance from the oscillating characteristics of a machine	FUN 37-47
When you want to start the VFD as soon as the power is turned ON	FUN 10
When you want to restart the VFD by resetting the fault when a fault occurs	FUN 48-49
When you want to use the instant power failure restart function	FUN 10
When you want to reduce noise or leakage current by changing the PWM carrier frequency	AFN 06
When you want to operate using PID feedback	AFN 60-77
When you want to initialize the parameters to factory defaults.	AFN 84
When you want to prevent the parameters from being changed	FUN 67-69
When you want to set the analog voltage or current for the frequency reference	FUN 06-07, I/0 26-35
When you want to change the functions for the input terminals D2-D10	I/O 01-10
When you want to check the status of the input/output terminals	I/O 69-70
When you want to check the fault history of the VFD	FH1-FH5
When you want to use the jogging and multi-step speed operation	FUN 08, I/O 20-26
When you want to change the alternate ramp profiles	AFN 29-40
When you want to set the frequency detection level	FUN 54-57
When you want to change the functions of the digital outputs and relays	I/O 11-17

FAULT DESCRIPTION

5.11 Fault Trip Description

When a Fault Trip occurs, the VFD cuts off its output and displays the fault status in the Active Fault group.

Table 35: SX Fault Codes

Fault Code	Fault Name	Possible Cause(s)	How to Recover
01	Watch Dog Trip	Consult Factory	Consult Factory
02	Power Bridge ID	• Ribbon cable not correctly seated between the power and control boards. • Electrical noise.	• Ensure that the ribbon cable is correctly seated. • Determine the source of the noise and eliminate it.
03	Current Calibr	Current sensors have an offset problem.	Consult factory.
04	TSP 24V Supply	Overloaded +24VDC supply.	Check the loading on the +24VDC supply and remove any excess load.
05	DC Volt Calibr	DC voltage is outside of normal limits on power up. This may be caused by: • High or low line voltage. • Supply voltage parameter incorrectly set.	• Check line voltage. • Check the AFN 15 (Supply Voltage) parameter.
06	IOC Trip	Output short-circuit. May also be caused by a ground fault (see Fault Code 11 below).	• Check motor wiring. • Extend acceleration ramp. • Reduce boost. • Check for ground faults.
07	Ext Flt/Warning (Fault)	The configured input sensed an external fault.	Investigate why the external fault occurred and correct.
09	Inter-Proc Comm	Loss of communication with the control terminal strip.	Reset the VFD by pressing the Stop key for more than 1 second. If problem persists, consult the factory.
11	Ground Fault	The VFD detected that the sum of the motor phases' current is not zero. This may be caused by insulation failure in the motor or the cables.	• Check motor wiring. • Check for and remove any capacitive load. • Check the motor and cabling for shorts to ground.
12	Input Phase Loss	Current measurement detected an input phase with no current.	Check input power cables.
13	Overvoltage	The voltage of the internal DC-link has exceeded 135% of the nominal voltage. This may be caused by incorrect deceleration time or high overvoltage spikes on line.	• Adjust deceleration time. • Add dynamic braking module.
14	Under Voltage	The DC bus voltage fell below 65% of the nominal voltage. This may be due to line supply failure or internal failure of the VFD.	Reset fault and attempt to restart. Check the line for proper supply. If fault persists, an internal fault has occurred; contact the factory.
15	DB Crct Failure	The dynamic brake (DB) is overloaded.	• Check for an open DB resistor. • Check for a shorted DB transistor. • Consult factory.
16	Motor Over Temp (Fault)	The VFD's motor temperature model detected motor overheating severe enough to cause a fault.	Decrease motor loading. If the motor is not overheated, check the temperature model parameters.
17	Output Fault	The output sensor detected an error.	• Check motor wiring. • Check for and remove any capacitive load. • Check the motor and cabling for shorts to ground.

Fault Code	Fault Name	Possible Cause(s)	How to Recover
18	Overcurrent	The VFD has measured excessive current in the motor output. This may be caused by: • Sudden, heavy load increase. • Short circuit in the motor cables. • Unsuitable motor.	• Check the load, motor size, and cables. • Review the settings for acceleration and deceleration times.
19	Drive Over Temp	Temperature of the VFDs heatsink is too high.	• Check the air flow. • Check that the heatsink is not clogged. • Check the ambient temperature. • Check that the switching frequency is not too high compared to ambient temperature and load.
20	Motor OverLoad	Excessive load on the motor (for example, a jammed load).	Check the motor and load.
21	Drive Under Temp	• Temperature of the VFDs heatsink is below 0 °C (32 °F). • Ribbon cable not correctly seated between the power and control boards.	• Increase the ambient temperature. • Ensure that the ribbon cable is correctly seated.
22	Motor Stall (Fault)	The motor's stall protection sensed a stall severe enough to cause a fault.	Check the motor.
23	Motor Underload (Fault)	The load on the motor is so insufficient (for example, a broken conveyor belt) that a fault occurs.	Check the motor and load.
24	TSP 10V Ref	10V reference for the analog input is overloaded.	• Ensure that the total load on the +10 terminal does not exceed 20mADC. • Check for correct connection of devices to the +10 terminal. • Check for short circuits associated with devices connected to the +10 terminal. • Consult factory.
25	EE Ref Checksum	Parameter restoring error due to interference fault or component failure.	Reset the fault and attempt a restart. If fault persists, contact the factory.
26	EE Par Checksum	Parameter restoring error due to interference fault or component failure.	Reset the fault and attempt a restart. If fault persists, contact the factory.
27	EEPROM Checksum	Parameter restoring error due to interference fault or component failure.	Reset the fault and attempt a restart. If fault persists, contact your local distributor or the factory.
28	Outpt Phase Loss	Current measurement detected a motor phase with no current.	Check motor cables.
29	Precharge Fault	Consult factory.	Consult factory.
30	TRIN Flt (ASIC)	Consult factory.	Consult factory.
31	Satur Flt (ASIC)	Consult factory.	Consult factory.
32	Empty Trp (ASIC)	Consult factory.	Consult factory.
33	Appl Change	Consult factory.	Consult factory.
34	High Unbal Curr	Consult factory.	Consult factory.
35	BMC Software	Consult factory.	Consult factory.
36	Lost of Ref (Fault)	The VFD detected the loss of the reference signal.	Restore the reference signal.
37	Lost of Ref (Warning)	The VFD detected the loss of the reference signal.	Restore the reference signal.
38	Broken Wire Trip (Fault)	The VFD detected a broken wire to Analog Input 1.	Check the control wiring for a broken wire and replace.
39	Broken Wire Trip (Warning)	The VFD detected a broken wire to Analog Input 1.	Check the control wiring for a broken wire and replace.
40	Loss of Keypad	Communication with the keypad is lost while keypad control is active.	Investigate and correct communication problem.
41	Ext Flt/Warning (Warning)	The configured input sensed an external fault.	Investigate why the external fault occurred and correct.

Fault Code	Fault Name	Possible Cause(s)	How to Recover
42	Ser Lnk TimeOut (Fault)	The programmed value of parameter AFN 27 (Com Timeout, see page 105) was exceeded.	Reset and restore serial link communications.
43	DI Logic Not Set	DI active logic is not set.	Set DI active logic via I/O 01 (Active Logic) parameter.
44	DI Logic Changed	Consult factory.	Consult factory.
45	DB Res Over Temp (Fault)	The internal dynamic brake (DB) resistor is too hot due to a peak overload.	Reduce the amount of time that the DB is applied. Reduce how often the dynamic brake is used. Check that parameters FUN 15 (DB Res Value), FUN 16 (DB Rth Value), and FUN 17 (DB Cth Value) correctly set. Reduce the load. Resize DB resister. Consult factory.
46	DB Res Over Temp (Warning)	The internal DB resistor is too hot due to a peak overload.	Same as for code 45.
47	DB Res Over Load (Fault)	Due to continuous overload, the load is more than the DB can safely handle.	Same as for code 45.
48	DB Res Over Load (Warning)	Due to continuous overload, the load is more than the DB can safely handle.	Same as for code 45.
49	MCP Fault	Consult Factory.	Consult Factory.
50	Loss of Fan	One of the fans is not draining current.	Check fans, replace bad fan.
51	Fan Warning	User has drive configured to warn drive.	Check fans, replace bad fan.
52	Motor Over Temp (Warning)	The VFDs motor temperature model detected motor overheating, but not severe enough to generate a fault.	Decrease motor loading. If the motor is not overheated, check the temperature model parameters.
53	Motor Stall (Warning)	The motor's stall protection sensed a stall, but not severe enough to cause a fault.	Check the motor.
54	Motor Underload (Warning)	The load on the motor is insufficient, but not so low that a fault occurs.	Check the motor and load.
55	DeviceNet Timeout (Fault)	No DeviceNet communication has occurred in the specified amount of time, and a fault occurs.	Reset and restore DeviceNet communication. See the DeviceNet manual for further information.
56	DeviceNet Timeout (Warning)	No DeviceNet communication has occurred in the specified amount of time, and a warning occurs.	Reset and restore DeviceNet communication. See the DeviceNet manual for further information.

Notes:

6 Interference Suppression Measures

INTRODUCTION

6.1 Introduction

Electrical/electronic devices are capable of influencing or disturbing each other through connecting cables or other metallic connections. Interference suppression measures (electromagnetic compatibility) consists of two elements: interference resistance and interference emission.

Correct installation of the inverter in conjunction with any possible local interference suppression measures has a crucial effect on minimizing or suppressing mutual interference.

GUIDELINES FOR INTERFERENCE SUPPRESSION

6.2 Guidelines for Interference Suppression

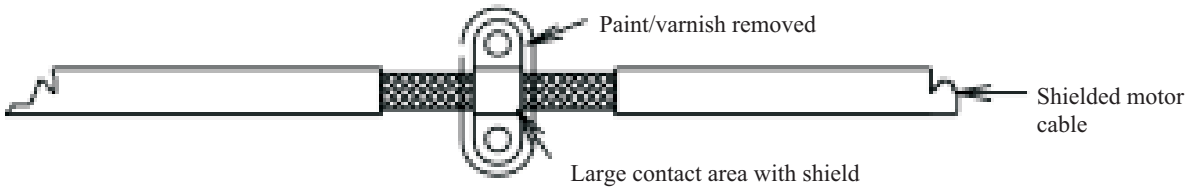
The following guidelines assume a power source that is not contaminated by high frequency interference. Other measures may be necessary to reduce or suppress interference if the power source is contaminated, and no general recommendations can be given for such cases. Please consult Benshaw's Electrical Application Engineering Department if the following recommended interference suppression measures do not produce the desired result.

Guidelines are as follows:

- When dealing with RFI (radio frequency interference), the surface area of the conductors is a more critical consideration than its cross sectional area. Since high frequency interference does not flow through the entire cross section of the conductor, but tends to stay toward its outer surface (skin effect), braided copper tapes of equal cross section should be used.

- A central grounding point should be used for interference suppression. Route the ground cables radially from this point, avoiding loops which may lead to interference. The inverter and all components used for interference suppression, particularly the shield of the motor cable, should be connected over as large a surface area as possible when passing over metallic surfaces. Remove the paint from contact surfaces to ensure a good electrical connection. See Figure 27 for recommended connection technique.

Figure 27: Recommended Connection Technique



- Take care not to damage the shield cross section when connecting it to the continuing lines. This raises the RF resistance of the shield and radiates rather than discharges the RF energy traveling on the shield. Shields, particularly those on control cables, must not be routed through pin contacts (plug connectors).

  When shielded cables must pass through a plug connection, use the metallic hand guard of the plug for the continuation of the shield. It is strongly recommended that the shield be uninterrupted whenever possible.

- Use a shielded motor cable which is grounded over a large surface area at both ends. The shield on this cable should be uninterrupted. If a shielded motor cable cannot be used, the unshielded motor line should be laid in a metal conduit or duct which is uninterrupted and grounded at both ends.

  When selecting shielded cable for use as motor leads, it is important to select a cable which is designed for operation at the frequencies and power levels involved. Improper selection of motor cable can cause high potential to exist on the shield. This could cause damage to the inverter and other equipment, and could pose a safety hazard.

- The following cables are acceptable for this purpose: OLFlex Series 150CY, 110CY, 110CS, 100CY, 100CS, and 540CP. Siemens CordaflexSM is also acceptable. Some of these cables are VDE-approved only; others carry VDE, UL, CSA, and combinations of these ratings. Be sure to confirm that the cable you are using meets the certification of the agency required.

  OLFlex cables are available from OLFlex Wire & Cable, 30 Plymouth Street, Fairfield NJ 07004, (800)-774-3539.

  Cordaflex cables are available from Siemens Energy and Automation, Inc., Power Cables, 3333 State Bridge Road, Atlanta GA 30202, (800)-777-3539.

- If the installation requires the use of an output reactor then the reactor, like the line filter, should be placed as close as possible to the inverter.

- Control wires longer than 3 feet (1 meter) must be run in shielded cable, and the shield must be terminated at circuit common (CM) on the inverter. Note that connection to CM rather than earth ground is allowed because RSi SX inverters have isolated control inputs. If the signal run exceeds 30 feet (9 meters), a 0-20 mA or 4-20 mA signal should be used, as it will have better noise immunity than a low level voltage.

- Other loads connected to the power source may produce voltage transients (spikes) that may interfere with or damage the inverter. Line reactors or filters can be used on the input power to protect the inverter from such transients.

- If the inverter is operated from switchgear devices or is in close proximity to switchgear devices (in a common cabinet), the following procedures are recommended as a precaution to prevent these devices from interfering with the inverter's operation:
  - ➜ Wire the coils of DC devices with freewheeling diodes. The diodes should be placed as close as possible to the physical coil of the device.
  - ➜ Wire the coils of AC devices with RC type snubber networks. Place the snubbers as close as possible to the physical coil of the device.
  - ➜ Use shielded cables on all control and monitoring signals.

- Route distribution cables (for example, power and contactor circuits) separately and as far away from control and monitoring signal cables as possible.

7 Options

STANDARD KEYPAD KIT

7.1 Standard Keypad Kit (for remote mounting)

The standard keypad is available for remote mounting use in your applications (maximum 2m or 6 feet). It is available in two kits. Kit 1 contains the display, gasket, and ribbon cable. Kit 2 contains the gasket and ribbon cable.

ENHANCED KEYPAD KITS

7.2 Enhanced Keypad Kits (for remote mounting)

The enhanced keypad is available for remote mounting or hand-held use in your application. It is available in either a white (part number RSiEKPW-01) or gray configuration (part number RSIEKPG-01).

IP31-IP21 CONVERSION KITS

7.3 IP31-IP21 Conversion Kits

The NEMA 1 / IP31 model may optionally be fitted with a kit for terminating shielded cable. Four kits are available, depending on the size of the model (the part numbers for the kits are RSiP01, RSiP02, RSiP03, and RSiP04).

These kits contain four clamps that slide into slots on the included cable plate. The clamps are used to terminate shielded cable. The cable plate easily replaces the conduit plate on the bottom of the NEMA 1 / IP31 model.

SIOC02 PROTOCOL CONVERTER

7.4 SIOC02 Protocol Converter

This product converts RS-232 protocol to RS-485 protocol.

REFLASH TOOL

7.5 Reflash Tool

The Reflash Tool allows you to upgrade the firmware of the RSi SX Sensorless Vector Drive. This allows the latest features to be implemented in existing hardware. For further information on this capability please contact Benshaw.

DYNAMIC BRAKING UNITS

7.6 Dynamic Braking Units

To augment the braking capacity of the RSi SX drive, consult factory.

DEVICENET OPTION BOARD

7.7 DeviceNet Option Board

The DeviceNet® Option Board (part number RSiDN01) provides an RS-485 interface to a DeviceNet network. It supports baud rates up to 500K. Contact Benshaw for further information.

METASYS OPTION BOARD

7.8 Metasys Option Board

The Metasys Option Board provides an RS-485 interface to a Metasys network. Contact Benshaw for further information.

ANALOG INPUT/OUTPUT OPTION BOARD

7.9 Analog Input/Output Option Board

The Analog Input/Output Option Board (part number RSiA10-01) provides up to three additional analog input channels, two additional analog output channels, and two additional relays for the RSi SX inverter. Contact Benshaw for further information.

FINS OUT KIT

7.10 Fins Out Kit

The Fins Out Kit allows you to mount the fins outside a host enclosure.

8 APPENDICES

APPENDIX A - EU DECLARATION OF CONFORMITY

EU DECLARATION OF CONFORMITY

Product Category:	Motor Controller
Product Type:	(ASD) Adjustable Speed Drives
Model Number:	RSi SX
Manufacturers Name:	Benshaw, Inc.
Manufacturers Address:	1659 East Sutter Road Glenshaw, PA USA 15116

The before mentioned products comply with the following EU directives and Standards:

Low Voltage Directive:	EN50178 - Electronic equipment for use in power installations
Electromagnetic Compatibility:	EN61800-3 - Adjustable speed electrical power systems - Part 3: EMC product standard including specific test methods

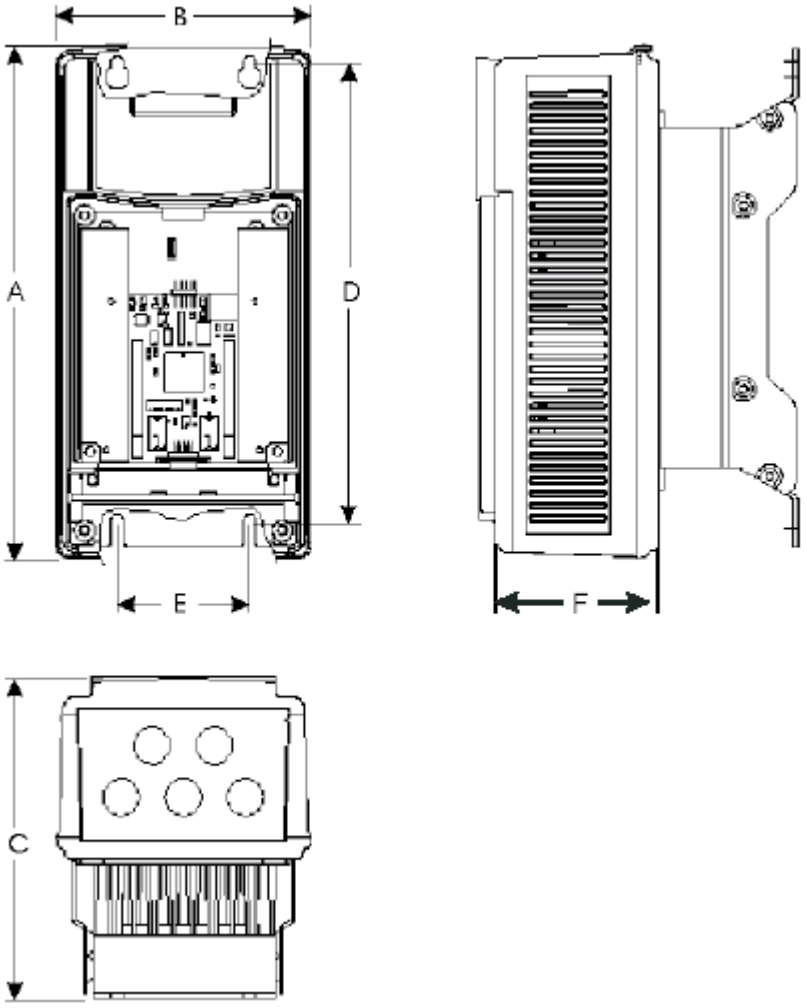
The products referenced above are for the use of control of the speed of AC motors.
For application information, consult the following document from Benshaw:
Publication Numbers 890020-01-01 and 890020-02-02.
The use in residential and commercial premises (Class B) requires an optional RSi LF series filter.
Via internal mechanisms and Quality Control, it is verified that these products conform to the requirements of the Directive and applicable standards.

Glenshaw, PA USA - 1 June 2002

Neil Abrams Qualtity Control Manager	Durand Miller VP General Manager

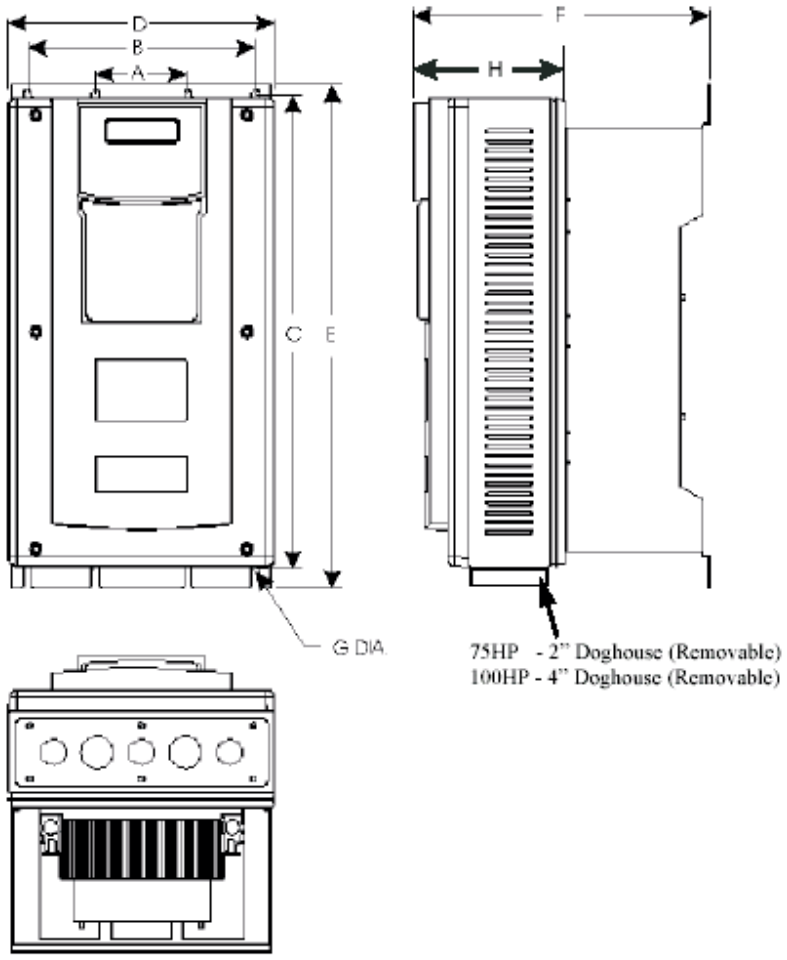
DIMENSIONS AND MODELS

Figure 28: Dimensions of 1 to 10 HP NEMA 1 / IP31 and NEMA 12 / IP55 Models



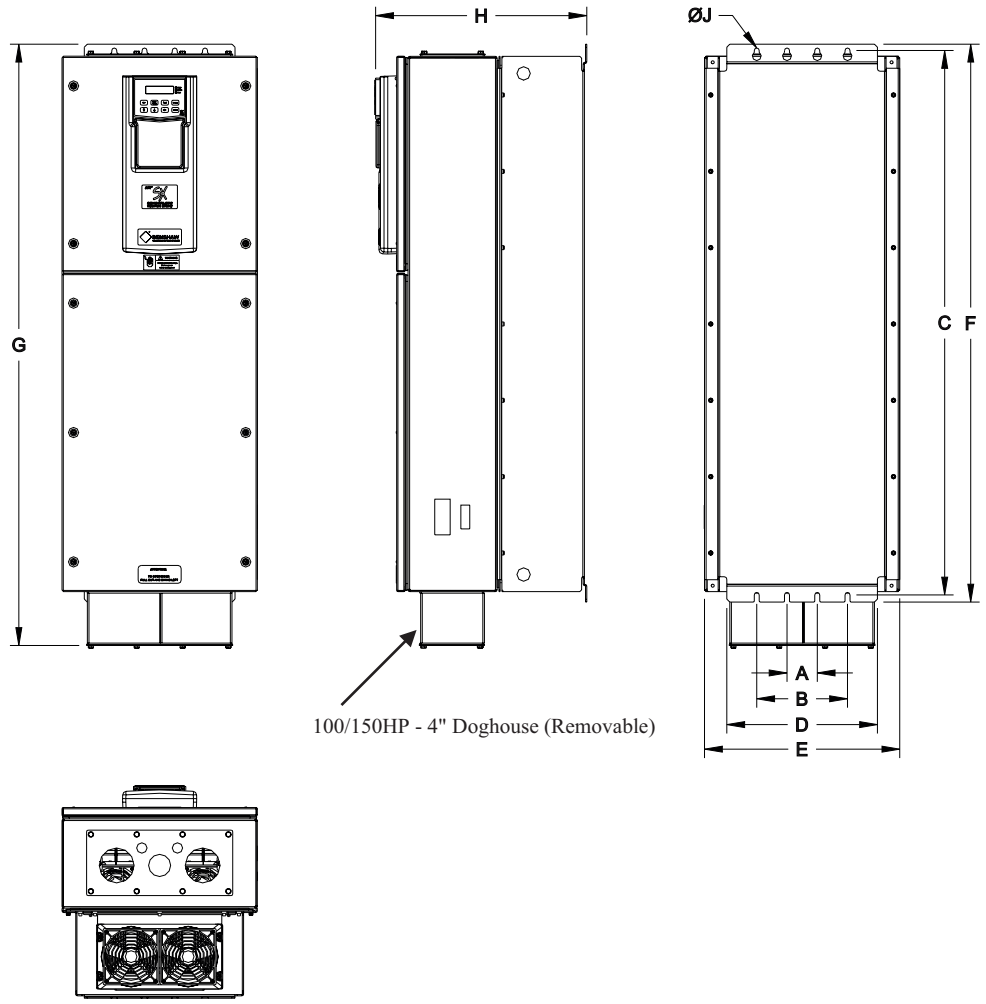
HP Rating	A in (mm)	B in (mm)	C in (mm)	D in (mm)	E in (mm)	F in (mm)
1 to 2	12.36 (313.7)	6.13 (155.7)	6.20 (168.1)	11.03 (280.2)	3.20 (81.3)	4.79 (121.7)
3 to 5	12.36 (313.7)	6.13 (155.7)	7.75 (196.9)	11.03 (280.2)	3.20 (81.3)	4.79 (121.7)
7.5 to 10	12.36 (313.7)	9.20 (233.7)	8.40 (213.4)	11.03 (280.2)	3.20 (81.3)	4.51 (114.6)

Figure 29: Dimensions of 15 to 75 HP NEMA 1 / IP31 and NEMA 12 / IP55 Models



HP Rating	A in (mm)	B in (mm)	C in (mm)	D in (mm)	E in (mm)	F in (mm)	G in (mm)	H in (mm)
15 to 20 230V	3.20 (81.3)	7.88 (200.2)	19.25 (489.0)	11.25 (285.8)	20.19 (512.8)	11.73 (297.9)	0.28 (7.1)	6.16 (156.5)
15 to 20 460/600V	3.20 (81.3)	7.88 (200.2)	16.50 (419.1)	9.20 (233.7)	17.44 (443.0)	10.30 (261.7)	0.28 (7.1)	5.25 (133.4)
25 to 40 460/600V	3.20 (81.3)	7.88 (200.2)	19.25 (489.0)	11.25 (285.8)	20.19 (512.8)	11.73 (297.9)	0.28 (7.1)	6.16 (156.5)
50 to 75 460/600V	3.20 (81.3)	7.88 (200.2)	28.00 (711.2)	12.50 (317.8)	31.37 (796.8)	14.00 (355.5)	0.42 (10.7)	8.51 (216.2)

Figure 30: Dimensions of 100 to 150 HP NEMA 12 / IP55 Models



HP Rating	A in (mm)	B in (mm)	C in (mm)	D in (mm)	E in (mm)	F in (mm)	G in (mm)	H in (mm)
100 to 150 460V	2.55 (64.77)	7.65 (194.31)	45.77 (1162.56)	12.70 (322.58)	16.46 (418.08)	46.90 (1191.26)	50.54 (1283.72)	17.80 (452.12)
100 to 150 600V	2.55 (64.77)	7.65 (194.31)	45.77 (1162.56)	12.70 (322.58)	16.46 (418.08)	46.90 (1191.26)	50.54 (1283.72)	17.80 (452.12)

WEIGHTS AND MODELS

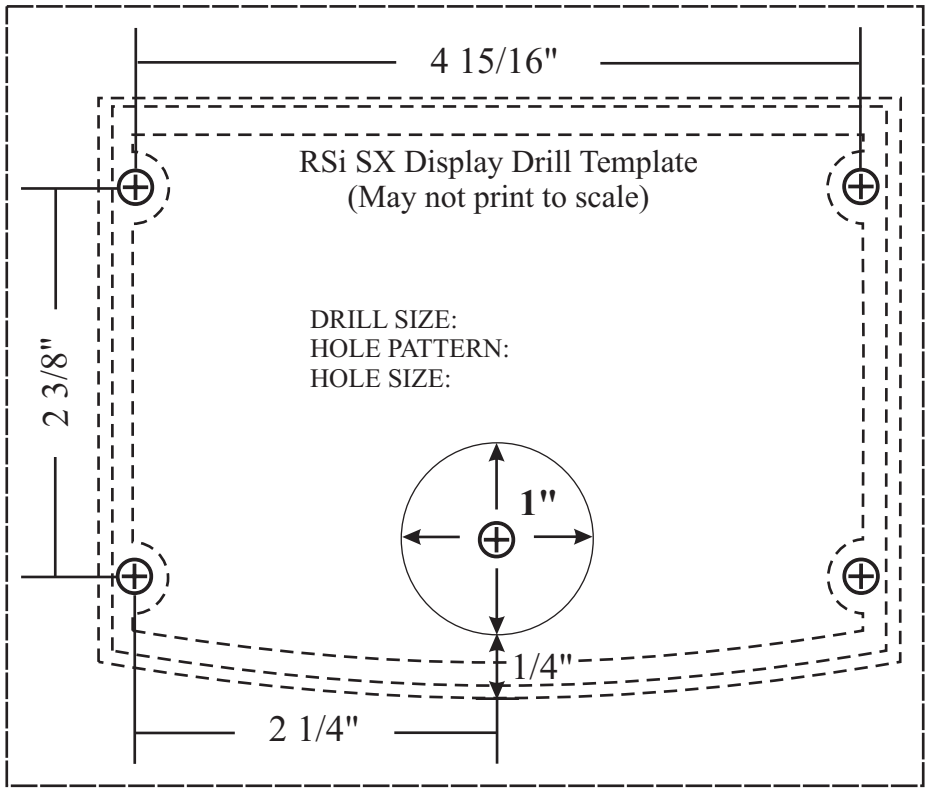
Table 36: NEMA 1 / IP31 and NEMA 12 / IP55 Models

Size	Power Ratings (HP)		Weight	
	230VAC	460 and 600VAC	Pounds	Kilograms
0	1	1	9.0	4.0
0	2	2	9.0	4.0
1	3	3	11.0	5.0
1	5	5	11.0	5.0
2	7.5	7.5	14.0	6.0
2	10	10	14.0	6.0
3	-	15	30.0	14.0
3	-	20	30.0	14.0
4	15	25	52.0	24.0
4	20	30	52.0	24.0
4	-	40 (460V)	60.0	27.0
4	-	40 (600V)	52.0	24.0
5	-	50	107.0	49.0
5	-	60	107.0	49.0
5	-	75	107.0	49.0
6	-	100	304[1]	138[1]
6	-	125	304[1]	138[1]
6	-	150	304[1]	138[1]

[1] Add 50LBS (23KG) for shipping weight.

RSi SX DISPLAY DRILL TEMPLATE

Figure 31



Revision History;

Revision	Date	ECO#	Description
00	01/08/02	#890020-01-00	Initial Release
01	19/04/04	E0795	Addition of size 6
	06/12/04		Troubleshooting Inserted

BENSHAW PRODUCTS

Low Voltage Solid State Reduced Voltage Starters

- RSD/RSM6 - SSRV Non or Separate Bypass
- RDB/RMB6 - SSRV Integral Bypass
- RSM7 - SSRV + DC Injection Braking
- RSM10 - SSRV + Reversing
- RSM11 - SSRV + DC Injection Braking + Reversing
- RSM10/12TS - SSRV Two Speed
- WRSM6 - SSRV Wound Rotor
- SMRSM6 - SSRV Synchronous
- DCB3 - Solid State DC Injection Braking

Medium Voltage Solid State Reduced Voltage Starters

- 5kV - Induction or Synchronous to 10,000HP
- 7.2kV - Induction or Synchronous to 10,000HP
- 15kV - Induction or Synchronous to 60,000HP

Low Voltage - AC Drives

- Standard Drives to 1000HP
- Custom Industrial Packaged Drives
- HVAC Packaged Drives
- 18 Pulse/IEEE 519 Compliant Drives

RSC Series Contactors

- SPO/SPE/SPD Motor Protection Relays
- Enclosed Full Voltage, Wye Delta, Two Speed Part Winding and Reversing Starters

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